THE

FOUNDRY TRADE JOURNAL

WITH WHICH IS INCORPORATED

THE IRON AND STEEL TRADES JOURNAL

VOL. 44. Thursday, May 21, 1931. No. 770.

PUBLISHED WEEKLY.

Subscription Terms: 15s. per annum.
Foreign and Colonial: 17s. 6d. per annum.
All Subscriptions are payable in advance.

All Communications to be addressed to the Editor, or to the Publisher, as the case may be, of
THE FOUNDRY TRADE JOURNAL,
49, WELLINGTON STREET, LONDON, W.C.2.

Telegraphic Address: "Zacatecas, Rand, London."
Telephone: Temple Bar 3951 (5 lines).

Contents.

	PAGE
Forthcoming Events	349
Railway Electrification and the Founding Industry	349
An Industrial Conscience for the South	349
The Birmingham Convention	350
World Output of Electric Steel Expands	350
B.C.I.R.A. Elects New Members	350
Random Shots	350
The Graphic Calculation of Cupola Mixtures with Special Reference to "Perlit" Cast Iron	351
The Brothers Pennington—Bell Founders	352
Refractory Materials for the Induction Furnace	352
Factors in the Growth of Cast Iron	353
Experiments with Fuel Oil in the Cupola	354
Recent Developments in Special Cast Iron	355
Catalogue Received	358
Institute of British Foundrymen	359
Foundry Selling Practice	360
Standardised Reagents and Metals for Metallurgical Control	360
Trade Talk	361
Personal	361
Contracts Open	361
Reports and Dividends	361
Cupola High-Test and Alloy Irons in a Machine-Tool and Grey-Iron Jobbing Foundry	361
Iron and Steel Markets	362

THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN; THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION, AND THE FOUNDRY TRADES EQUIPMENT AND SUPPLIES ASSOCIATION.

Institute of British Foundrymen.

PRESIDENT: 1930-31:
F. P. Wilson, J.P.,
"Parkhurst," Middlesbrough.

LIST OF SECRETARIES—

General Secretary: T. Makemson, Saint John Street Chambers, Deansgate, Manchester. London Office: 49, Wellington Street, London, W.C.2.

Birmingham: F. K. Neath, 24, St. Paul's Square, Birmingham.

Sheffield: T. R. Walker, 33, Ladysmith Avenue, Nether Edge, Sheffield.

Scottish: J. Bell, 60, St. Enoch Square, Glasgow.

Lancashire: J. E. Cooke, 1, Derbyshire Crescent, Stretford, Manchester.

London: Sydney Evans, 22-23, Laurence Pountney Lane, Cannon Street, London, E.C.4.

Newcastle-upon-Tyne: J. W. Eckford, 4, Mosely Street, Newcastle-upon-Tyne.

East Midlands: H. Bunting, 82, Otter Street, Derby.

West Riding of Yorkshire Branch: S. W. Wise, 110, Pullan Avenue, Eccleshill, Bradford.

Wales and Monmouth Branch: J. J. McClelland, 12, Clifton Place, Stow Hill, Newport, Mon.

Middlesbrough: F. A. Harper, "The Briars," Bishopton Road, Stockton-on-Tees.

Foundry Trades Equipment and Supplies Association.

President: D. H. Wood,
Titan Works, Charles Henry Street, Birmingham.

Secretary: K. W. Bridges, Grand Buildings, Trafalgar Square, London, W.C.2

Welsh Engineers' and Founders' Association.

Secretary: E. J. Griffiths, 2, Royal Metal Exchange, Swansea.

BRITISH CAST IRON RESEARCH ASSOCIATION.

The Registered Office and Laboratories of the B.C.I.R.A. are at:—
24, ST. PAUL'S SQUARE, BIRMINGHAM.
Telephone: Central 1895. Telegrams: CIRA.
The B.C.I.R.A. Scottish Laboratories are:—
Foundry Technical Institute, Meek's Road, Falkirk *(Telephone 332).*

Forthcoming Events.

MAY 28.

Institution of Welding Engineers:—Annual general meeting in London.

Institute of British Foundrymen.

JUNE 9-12.

Annual Conference at Birmingham.

JUNE 13.

Lancashire Branch:—Visit to works of Linotype & Machinery, Limited, Altrincham.

Railway Electrification and the Founding Industry.

At least one important Government Committee has omitted in its report to play for safety, and the Committee, presided over by Lord Weir, has boldly plumped for a policy of railway electrification, spread over a period of twenty years and costing nearly four hundred millions sterling. The main-line electrification would cost just over two hundred and fifty millions, and would, it is estimated, yield a return of 7 per cent.

The advantages of electric traction, particularly its cleanliness, operating convenience and general speeding-up through rapid acceleration and deceleration are admitted even by locomotive engineers. The only question for them is that so much capital has been sunk in steam equipment that it cannot possibly be scrapped. Such an argument would perpetuate the steam system, and probably ultimately result in the subordination of railways to roads, whereas electrification not only yields great economic advantages, but it offers prospects of great social benefits in the form of improved stations and termini to replace the present melancholy mausoleums, memorials of the Victorian age, through which the brooding traveller is compelled to come and go. The argument for suburban electrification is already answered by the Southern and by some parts of the provinces, such as Liverpool—Southport, Manchester—Altrincham, and the Newcastle to the coast lines.

While the report points out the magnitude of the scheme, which must be undertaken for the country as a whole, it stresses also that in ten years we have spent five hundred millions on roads, and are still spending at the rate of over sixty millions per annum. The Swiss Railways carry 85 per cent. of their traffic on electrified lines, which amount to two-thirds of the total mileage, at a saving of over £200,000 per annum over steam traction. We can make electricity from coal at a price which compares favourably with electricity from water power, and the Central Electricity Board has quoted a half-penny a unit as a suitable price for current from the national grid. The scheme would employ over 60,000 men for a period of twenty years.

The founding industry cannot fail to be interested in a scheme which offers such scope for its products as an electrification scheme, or to remain indifferent to the fate of the report at the hands of the Government. There are possibilities for all in the scheme; for, while the main-line current would be generated in power stations of the usual type, the branch lines might conceivably be run on a heavy oil-electric system. Altogether a very bold and suggestive report, and one which shows that the railways have by no means been subdued by their greatly favoured and privileged rivals, the roads.

An Industrial Conscience for the South.

Some little time ago we made a plea in this column for an amalgamation of the London Coal and the London Iron and Steel Exchanges, believing that such an action would give an excellent service to foundries and engineering establishments in the South of England. We now confess that we were unaware that there are special conditions attached to the Coal Exchange which effectually prevents any such amalgamation. However, we still feel that there is a real need for the London Iron and Steel Exchange to broaden its sphere of activity by serving the local foundry industry. This can only be done by assuring the regular attendance of a maximum of buyers and sellers, both categories comprising manufacturers and merchants.

Conversations with district foundry owners have generally produced the following observation:—"Why should I send my buyer or go myself weekly to London, when all the salesmen call on me at my works?" The answer is that when real bargains exist, the selling firm has no need to go twenty to forty miles from London and so increase his selling costs, but he immediately disposes of them to the merchants on the Exchange.

Again, foundry owners manufacture something or other, and surely likely buyers are to be found on any well-attended Exchange. Moreover, as we tried to convey in the previous editorial on this subject, the average Southern manufacturer is more familiar with the industrial structure of the North and Midlands than with those located on the other side of London.

One ideal to be created by such an Exchange is an industrial consciousness for the South of England. A junior clerk in Manchester, Glasgow, Sheffield or Birmingham is a walking directory of the local industries, but in the London area even the owners and managers of large concerns are lamentably ignorant of the location and personnel of this newer and ever-growing industrial district.

We know of no better means of establishing useful industrial contacts than by enthusiastically supporting for a considerable period the London Iron and Steel Exchange, and always working for its extension and, therefore, its usefulness to Southern industries.

Such an establishment on a wider basis should result in a reduction of useless travelling, trunk telephoning and telegraphing, and in general cheapen both the cost of buying and selling. Moreover, it would create for the South the characteristic features of British industry which are established as being essentially useful in the Midlands and North. We ask all our readers to make an effort to ensure that the question of joining the London Iron and Steel Exchange is prominently brought to the notice of the owner or directorate for consideration.

XUM

The Birmingham Convention.

Below we print the first list of subscriptions made to the Reception Committee responsible for organising the forthcoming Birmingham Convention of the Institute of British Foundrymen. It amounts to £278 10s., and comprises £81 8s. contributed through the Foundry Trades' Equipment & Supplies Association, Limited, as follows:—

	£	s.	d.
Alldays & Onions, Limited	2	2	0
Allen, T. Fearnley, & Son	3	3	0
Atlas Preservative Company, Limited	1	1	0
August's Muffle Furnaces, Limited ...	5	5	0
Beecroft & Partners, Limited ...	2	2	0
Blackfriars Foundry Requisite Company, Limited	3	3	0
Bradley & Foster, Limited	3	3	0
Coleman Foundry Requisite Company, Limited	3	3	0
Constructional Engineering Company, Limited	10	10	0
Cumming, Wm., & Company, Limited	10	0	0
Durrans, James, & Sons, Limited ...	5	5	0
Fordath Engineering Company, Limited	10	10	0
Foundry Trade Journal	5	5	0
Harrison Bros. (England), Limited ...	5	5	0
Sterling Foundry Specialties, Limited	3	3	0
Universal System of Machine Moulding & Machinery Company, Limited	5	5	0
Wilkinson, Thos., & Company, Limited	3	3	0

This first list is completed by the following subscriptions:—

W. & T. Avery, Limited	26	5	0
Daimler Company, Limited	15	15	0
Morris Motors, Limited...	15	15	0
Austin Motor Company, Limited ...	10	10	0
Alfred Herbert, Limited	10	10	0
Sterling Metals, Limited	10	10	0
F. H. Lloyd & Company, Limited ...	10	10	0
Coventry Malleable & Aluminium, Limited	10	10	0
Mr. C. B. Pugh	5	5	0
Bailey, Pegg & Company, Limited ...	5	5	0
Mr. D. Wilkinson	5	5	0
Goldendale Iron Company, Limited ...	5	5	0
Carborundum Company...	5	0	0
Wm. Mills, Limited	5	0	0
Belliss & Morcom, Limited	5	0	0
Cannon Ironfounders, Limited ...	3	3	0
Rowland Hill & Sons, Limited ...	3	3	0
J. Harper & Company, Limited ...	3	3	0
R. Hyde & Son, Limited	2	2	0
Malleable, Limited	2	2	0
Mr. and Mrs. T. H. Gameson	2	2	0
Brightside Foundry & Engineering Company, Limited	2	2	0
Mr. E. N. Wright	2	2	0
Mr. W. C. M. James	2	2	0
Mr. J. G. Pearce...	2	2	0
Penton Publishing Company	2	2	0
Mr. J. H. Mees	1	1	0
Mr. H. Phillips	1	1	0
Mr. H. J. Roe	1	1	0
Mr. W. J. Flavell, J.P....	1	1	0
Mr. G. Moran	1	1	0
Mr. C. Heggie	1	1	0
Mr. H. C. Heggie	1	1	0
Mr. J. H. Westwood	1	1	0
W. & J. Lawley	1	1	0
Brookes (Oldbury), Limited	1	1	0
Mr. M. H. Curnow	1	1	0
Universal Grinding Wheel Company, Limited	1	1	0
Mr. C. R. Smith	1	1	0
Mr. W. Baker	1	1	0
Mr. A. B. Smith	1	1	0
G. & R. Jackson, Limited	1	1	0
Tangyes, Limited	1	0	0
Mr. J. B. Johnson	1	0	0
Mr. E. J. Lewis	1	0	0
Mr. S. W. B. Flavel	1	0	0
Mr. S. Glover	1	0	0
Mr. T. G. Bamford	0	10	6
Mr. A. H. Newsum	0	10	6
Mr. T. G. Wragg	0	10	0
Mr. A. J. Shore	0	10	0
Mr. G. Hamilton	0	5	0
Mr. W. Vickers	0	5	0
Mr. G. Walker	0	5	0
	197	2	0
Foundry Trades' Equipment & Supplies Association, Limited (as set out in the first column)	81	8	0
	278	10	0

In order to facilitate the work of organising the Convention, donations should be sent as early as possible to Mr. F. K. Neath, B.Sc., at 24, St. Paul's Square, Birmingham.

World Output of Electric Steel Expands.

Only recently, states the "Iron Age," have data become available covering the detailed output of electric steel in 1929 for all countries of the world. From these it is now possible to compile a table giving the electric-steel production of the countries which produce this grade of steel. The data for 1929 compared with 1928, and in some cases with 1913, are as follow, in gross tons:—

World Electric-Steel Output.

	1929.	1928.	1913.
United Kingdom ..	86,800	78,400	—
United States ..	951,431	802,260	34,011
France	151,001	128,299	21,124
Germany	209,277*	195,761*	88,881
Belgium	14,450	—	—
Luxemburg.. ..	9,962	—	—
Japan	40,000 (est.)	34,473	4,329 (1918)
Italy	200,000 (est.)	190,000 (est.)	36,948 (1917)
Poland	18,317	18,614	16,187
Sweden	112,702	85,886	2,276
Canada	52,760	30,014	449

* Including crucible steel.

Thus the total world electric-steel output for 1929 was approximately 1,846,600 tons, which compares with about 1,586,700 tons in 1928—an increase for 1929 of about 16 per cent. The American output, both in 1929 and 1928, was easily more than 50 per cent. of the world total. In 1913, Germany was easily the leader, but holds second position now. The expansion for Italy since 1917 is outstanding, as is also that of Sweden. It is probable that 1930 will make a poor showing compared with 1929. The data will not be available for several months.

B.C.I.R.A. Elects New Members.

The following is a list of new members of the British Cast Iron Research Association:—

Ordinary Members.—Henry Edie & Company, Limited, London; Hepworth & Grandage, Limited, Bradford; National Steel Foundry (1914), Limited, Leven; Ontario Research Foundation, Toronto, Canada; W. Rollinson & Sons, Limited, Nottingham; The Southern Railway Company, Limited, London.

Trade Members.—The Lancashire Foundry Coke Company, Limited, and William Jacks & Company, London.

Asbestos rope, soaked in a fireclay paste, can be used to caulk cracks in furnace brickwork. A mixture of hot gas tar and Portland cement can be used to seal porous or cracked brickwork.

Random Shots.

I suppose that America more than any other nation has sought to multiply the applications of metal to architecture. In this direction a quite recent development is the "Aluminaire"—a house constructed mainly of steel, aluminium and glass, with suspended aluminium-covered walls and steel battledeck floors. What appeals to me more strongly than these novelties is the living-room, which extends two floors in height and has one entire side glazed with ultra-violet glass. Neon tubes, parallel to the tops of the windows, provide either white, coloured or ultra-violet light by the turn of a dial.

* * *

Another American development for which there must exist an enormous potential demand is a vitreous-enamelled pressed-steel wall tile. Consider, for a moment, just one of its numerous uses—for the bathroom. Allowing America's 31 million families at least two bathrooms each, and x tiles per bathroom—well, 62,000,000 x tiles constitutes a market worth entering.

* * *

It was, I believe, Mr. P. B. Brown who, speaking at an I.B.F. dinner in Sheffield, mentioned the manufacture in the States of steel coffins, and said—amid laughter—that he thought of trying to sell some heat-resisting steel to the manufacturers.

* * *

Despite the times, the Chicago Convention of the American Foundrymen's Association declined to be marred by poor attendance. The 1929 record was broken by the 2,200 or more who registered this year. Whilst the Institute of British Foundrymen has to content itself with something like an eighth of this figure, there are always records waiting to be broken, and, as a gesture of amicable rivalry to our transatlantic friends, we ought to set ourselves to beat our own record. An unofficial attraction of this year's Birmingham Conference is free joy-riding round the foundries on the sand and core conveyors.

* * *

Imaginary Intimate Interviews.

V. *The Pig-Iron Salesman.*

I'm known throughout the country as the "Foundryman's Good Samaritan" because my policy has always been to help the small country jobbing foundries. Before I start talking business to a new customer I make it a point to discover whether he works to analysis. If he doesn't, well and good. If he is not sure what manganese and silicon are, better still. Then I can offer to supply him with a pig-iron of correct composition for his requirements. Suppose, for instance, he is making ploughshares. I tell him that he wants an iron with a minimum of 30 per cent. manganese, not more than 26.5 per cent. silicon, less than 0.02 per cent. total carbon, and at least 10 per cent. nickel. This iron will suit his purposes admirably, and he can use with it as much old scrap as he likes. More often than not I book his order. And more often than not, on my next visit, he complains that his shares won't plough butter. I immediately reply that shares were never intended to plough butter, that his scrap is of inferior quality, his cupola worn out and his sand not even fit for Southend beach. He must cut down his scrap, use less coke, and then he will get perfect castings. And after some discussion in the "Red Lion" he agrees with me.

Marksman.

The Graphic Calculation of Cupola Mixtures, with Special Reference to "Perlit" Cast Iron.

B. Szöke has described a graphic method with the aid of which the proportion of the different components of a mixture can easily be determined when the molten iron is to contain a definite percentage of one of its constituents, *e.g.*, silicon.* The method can be applied when two or three different kinds of pig-iron are used together with returned scrap, runners and risers, on condition that the latter contain the same silicon content as the molten iron.

The following notation is used:

Returned scrap contains A per cent. of Si; the proportion in the mixture is P per cent.

Pig-iron I contains a_1 per cent. of Si; the proportion in the mixture is x per cent.

Pig-iron II contains a_2 per cent. of Si; the proportion in the mixture is y per cent.

Pig-iron III contains a_3 per cent. of Si; the proportion in the mixture is z per cent.

First the case may be discussed when two different pig-irons are taken into the mixture together with returned scrap. In this case the following two equations hold good:

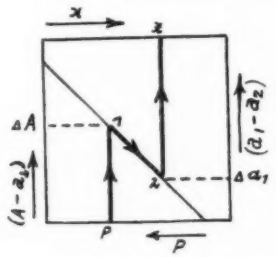


Fig. 1.

$$a_1x + a_2y + PA = 100A$$
$$x + y + z = 100.$$

With $100 - P = Q$ we get

$$a_1x + a_2y = A(100 - P) = AQ \quad (1)$$

and

$$x + y = Q \quad (2)$$

By introducing $y = Q - x$ into equation (1) we get

$$x(a_1 - a_2) = Q(A - a_2) \quad (1a)$$

In a former Paper the author has stated that the product $x\ (a_1 - a_2)$ is represented by an equilateral hyperbola, and that this curve can be used for determining the value of x. The determination is simplified by using logarithmic squared paper because in this case the hyperbola is represented by a straight line. From equation (1a) it follows:

$$\log. x + \log. (a_1 - a_2) = \log. Q + \log. (A - a_2) \quad (1b)$$

If the right side of the latter equation is regarded to be constant, then the equation $\log. Q + \log. (A - a_2) = K$ (constant) is represented by a straight line intersecting the two main axes at an angle of 45 deg. This line can be plotted because, besides the angle of 45 deg., another geometrical locus of the line is known, viz., the intersection point of the two co-ordinates representing the values of Q and $(A - a_2)$. According to equation (1b) the intersection point of the two co-ordinates representing the values of x and $(a_1 - a_2)$ must also lie upon the plotted line. Therefore for the determination of x a graph can be designed, a sketch of which is illustrated in Fig. 1. On the bottom abscissa the values of Q are plotted from the left to the right (that is, those of $P = 100 - Q$ in the opposite direction), on the left-handed ordinate the values of $\triangle A = A - a_2$ from bottom to top, on the right-handed ordinate those of $\triangle a_1 = a_1 - a_2$ in the same direction, and on the top abscissa the values of x from the left to the right. x is then determined as follows. First the values of $\triangle A$ and $\triangle a_1$ are computed. Then from point P on the bottom abscissa one goes vertically upwards to the horizontal line drawn through point $\triangle A$ on the left-handed ordinate, the intersection being point 1. Along the 45 deg.-line running through point 1 one advances to the horizontal line drawn through point $\triangle a_1$ on the right-handed ordinate, point 2. From the latter point one goes vertically upwards and finds the value of x on the top abscissa. Y can be computed from the equation $y = 100 - x - P$. For illustration: the melt is to contain A = 2.0 per cent. of silicon, and the following components are to be taken into the mixture: P = 20 per cent. of wasters containing A = 2.0 per cent. of Si, x per cent. of pig-iron I containing $a_1 = 2.34$ per cent. of Si and y per cent. of pig-iron II containing $a_2 = 1.7$ per cent. of Si. Then $\triangle A = 0.3$ and $\triangle a_1 = 0.64$. Starting from point P = 20 on the bottom abscissa of Fig. 2 one proceeds in the same way as described above and finds on the top abscissa the value $x = 37.5$ per cent. Then

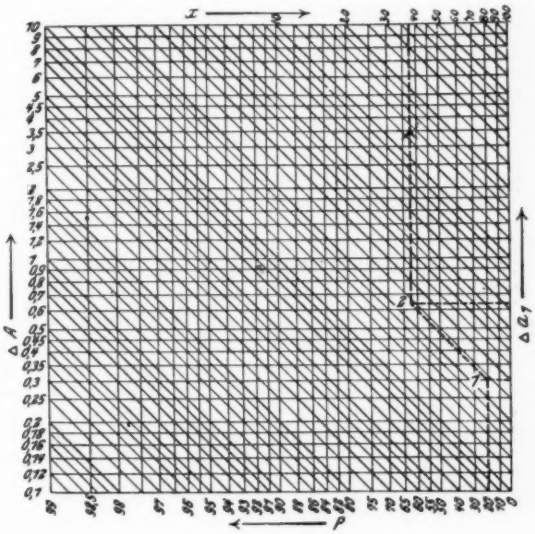


Fig. 2.

$y = 100 - 37.5 - 20 = 42.5$ per cent. The accuracy of the method can be checked by the following computation:

$$2.34\,\frac{37.5}{100} + 1.7\,\frac{42.5}{100} + 2\,\frac{20}{100} = 0.8775 + 0.7225 + 0.4 = 2.$$

In the case the two values of $\triangle A$ and $\triangle a_1$ become negative (*e.g.* when in the example given above a_1 and a_2 are exchanged for one another: $a_1 = 1.7$ and $a_2 = 2.34$, then $\triangle A = -0.34$ and $\triangle a_1 = -0.64$) they are both multiplied with -1. For both the sides of equation (1a) can be multiplied with same number without influencing the result. If, however, $\triangle A$ and $\triangle a_1$ have different signs the problem cannot be solved, and other pig-irons must be chosen.

The Graphic Method.

Mixtures for making "Perlit" cast iron can also be calculated with the aid of the graphic method. In the "Perlit" process the mould is preheated to a definite temperature, the degree of which depends upon the wall thickness of the casting and the composition of the iron. By properly preheating the mould, the cooling rate of the casting is so regulated that the structure of the casting is pearlitic throughout. The relationship between the three factors, wall thickness, chemical composition and mould temperature, is shown in the diagram in Fig. 3. As to the chemical composition of the iron, only the total of the carbon and silicon contents plays a part. The standard mixture contains 4 per cent. of (C + Si), and is used, as Fig. 3 shows, chiefly with wall thicknesses of from 30 to 60 mm. With thinner wall thicknesses, this mixture requires too high a preheating temperature, which in practice would be difficult to obtain. Therefore, in this case, a softer mixture is used containing 4.6 per cent. of (C + Si). With wall thicknesses over 60 mm. a harder mixture is preferably used, containing 3.4 per cent. of (C + Si). The calculation is as follows: The mixture is to contain the following components:—

P per cent. of scrap containing A per cent. of C and B per cent. of Si.

x per cent. of pig-iron I containing a_1 per cent. of C and b_1 per cent. of Si.

y per cent. of pig-iron II containing a_2 per cent. of C and b_2 per cent. of Si.

As only the total of carbon and silicon must be taken into account, the following two equations hold good:—

$$(a_1 + b_1)x + (a_2 + b_2)y = (A + B)Q \quad (3)$$
$$x + y = Q$$

By introducing the following designations into equation (3),

$$a_1 + b_1 = c_1$$
$$a_2 + b_2 = c_2$$
$$A + B = C$$
$$y = Q - x$$

we get $c_1x + c_2(Q - x) = CQ$

or

$$x(c_1 - c_2) = Q(C - c_2) \quad (3a)$$

This equation is of the same form as equation (1a), and, therefore, x can be determined with the aid of the graph shown in Fig. 2 in the same manner as described above, after the values of

$$\triangle C = C - c_2 = A + B - (a_2 + b_2) \text{ and}$$
$$\triangle c_1 = c_1 - c_2 = a_1 + b_1 - (a_2 + b_2)$$

have been computed. On the left-handed ordinate of the graph $\triangle C$ is read instead of $\triangle A$, and on the right-handed ordinate $\triangle c_1$ instead of $\triangle a_1$.

In the following the method will be applied to the case when three different pig-irons are to be taken into the mixture. Here the problem is mathematically indefinite, as the solution does not afford a single value for x, y and z respectively, but a great many groups of values. If, however, from the group of the x-values a definite value has been chosen, then definite values of y and z will correspond to this x-value. Thus, the percentages of the pig-irons can be arbitrarily chosen within certain limits, which is of

* "Die Giesserei," 1930, No. 42.

great practical importance, *e.g.*, with respect to selling costs. The mixture is to contain:—

P per cent. of scrap containing A per cent. of silicon,
x „ „ pig-iron I „ a_1 „ „
y „ „ „ II „ a_2 „ „
z „ „ „ III „ a_3 „ „

The following two equations hold good:—

$$a_1 x + a_2 y + a_3 z = AQ \quad (4)$$
$$x + y + z = Q \quad (5)$$

By introducing the following designations into equation (4)

$$z = Q - x - y$$
$$\Delta a_1 = a_1 - a_3$$
$$\Delta a_2 = a_2 - a_3$$
$$\Delta A = A - a_3$$

we get $\Delta a_1 x + \Delta a_2 y = \Delta AQ \quad (4a)$

From this equation x is determined with the aid of the nomogram shown in Fig. 4, which has been designed by H. Pflieger-Härtel. It

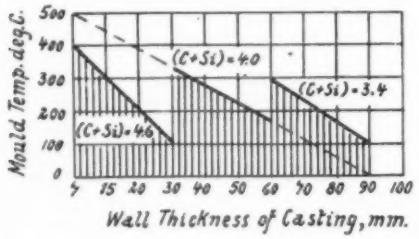


Fig. 3.

consists of a main graph and an auxiliary graph on the left. On the ordinate of the latter the values of $\triangle$ A are read, and on the abscissa those of P. The convergent rays of the auxiliary graph intersect in point P = 100. On the two ordinates of the main graph the values of x and y are read from bottom to top, on the bottom abscissa the values of $\triangle a_2$ from the left to the right, and on the top abscissa those of $\triangle a_1$ in the opposite direction. The working of the nomogram is as follows:—From point P on the abscissa of the auxiliary graph one goes vertically upwards to the convergent line drawn through point $\triangle$ A on the ordinate, point 1. The horizontal line drawn through point 1 is produced into the main graph. Then, from point

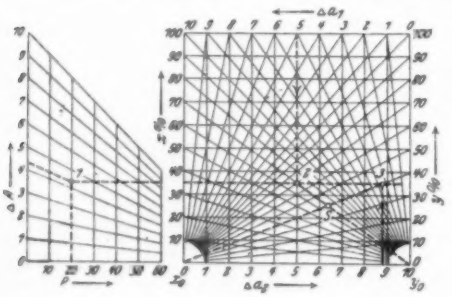


Fig. 4.

$\triangle a_1$ on the top abscissa of the main graph one goes vertically downward to the horizontal line, point 2, and from point $\triangle a_2$ on the bottom abscissa vertically upwards to the horizontal line, point 3. The rays 2 . . . y_0 and 3 . . . x_0 intersect in point S. Then, every straight line running through point S intersects the two ordinates of the main graph in points which afford corresponding values of x and y (see Fig. 5). Z can be computed from the equation $z = 100 - (P + x + y)$. Of course, only those solutions are of practical value in which neither of the three values x, y and z is negative nor greater than 100.

The calculation of a mixture for "Perlit" cast iron containing three different pig-irons is as follows:—The mixture is to contain the following components:—

P per cent. of scrap with a total content of (C + Si) = A + B = C
x per cent. of pig-iron I with a total content of (C + Si) = $a_1 + b_1 = c_1$.
y per cent. of pig-iron II with a total content of (C + Si) = $a_2 + b_2 = c_2$.
z per cent. of pig-iron III with a total content of (C+Si) = $a_3 + b_3 = c_3$.

The following two equations hold good:—

$$c_1 x + c_2 y + c_3 z = CQ \quad (6)$$
$$x + y + z = Q \quad (5)$$

By introducing the following designations into equation (6)

$$z = Q - x - y$$
$$\Delta c_1 = c_1 - c_3$$
$$\Delta c_2 = c_2 - c_3$$
$$\Delta C = C - c_3$$

we get $\Delta c_1 x + \Delta c_2 y = \Delta CQ \quad (6a)$

As the latter equation is of the same form as equation (4), it can also be solved with the aid of the nomogram shown in Fig. 4, after the values of $\triangle c_1$, $\triangle c_2$ and $\triangle$ C have been computed. From equation (6a) it follows that the latter values can be multiplied by the same number without influencing the result. This possibility will be made use of, if, because of the smallness of these values point S will lie too near the abscissa, an indistinct intersection being the result.

The calculation of a mixture containing three different kinds of pig-iron can also be carried

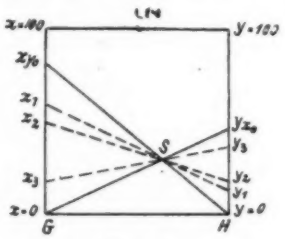


Fig. 5.

out with the aid of the graph shown in Fig. 2. From Fig. 5 it follows that with x = O (that is in case pig-iron I is not used at all) $y = y_{x_0}$. Therefore, one can determine the latter value from Fig. 2 by taking into account only the irons II and III. In the same manner x_{y_0} (with y = O) is determined with the aid of the irons I and III. The two values thus found are plotted on the ordinates of a graph like that shown in Fig. 5, the length of the abscissa GH being at will. With the aid of the rays G . . . y_{x_0} and H . . . x_{y_0} the intersection point S is obtained which, in its turn, affords all the corresponding values of y and x.

Continental Steel Cartel.

It is understood that an agreement has been reached regarding the proposals to be placed before the managing committee of the Continental Steel Cartel in the matter of the rearrangement of the Cartel on the basis of separate quotas for the home and export trades. The question of fixing these quotas is being considered at a meeting in Paris.

Oil should never be allowed to lie on concrete or rotting will result. Concrete foundations should be painted to protect them from oil.

Dechema German Society for Chemical Apparatus.—The programme of the 5th general meeting of this Society, which is to take place in Vienna from May 28 to 30, 1931, has now been issued. The meeting will be concerned with the discussion of the important subject of "The Separation of Liquids and Solids."

The Brothers Pennington—Bell Founders.

It is incorrect, as has been stated in various London daily newspapers, that the old bells of St. Budeaux Parish Church, Plymouth, which have been taken down for rehanging, were rung for the marriage in that church of Sir Francis Drake to Mary Newman, a Saltash fisherman's daughter. The registers of the church record the burial there of Lady Drake in 1583, but the oldest of the peal of six bells, namely the tenor, bears the date 1749. This bell was cast by Tho. Bilbie, and three of the others by John Pennington in 1780. Both of these firms did excellent work, and the brothers Pennington were especially famous in East Cornwall and West Devon. They were travelling craftsmen, and set up their temporary foundry in churchyards or neighbouring fields. Their bells, it is pointed out by an authority, have lived through the most troublous times of church bell history.

The St. Budeaux bells have not been rung for some time now owing to the decay of the oak frame making it unsafe to use them. They have been removed from the belfry for the purpose of being hung in a cast-iron frame on a foundation of steel, and fitted with ball bearings and all the improved devices of the bell-making art. The work is to cost about £500, and is being carried out by J. Taylor & Company, Loughborough, a firm which was founded a century ago by a native of Buckland Brewer, North Devon.

Refractory Materials for the Induction Furnace.

Dr. J. H. Chesters and Mr. W. J. Rees, in a Paper to the Iron and Steel Institute, summarised their researches as follow:—

Linings of magnesia were used in the original horizontal ring induction furnace. In the coreless furnace, fireclay and graphite crucibles have been used, but for the production of steel in quantity durable linings of silica or magnesia, with bonds such as boric acid, have been developed. Besides refractoriness, other characteristics required in coreless furnace-lining materials are ability to sinter, corrosion resistance, and low burning shrinkage. Grading is an important factor in the ability to sinter and in the lining life. The slag resistance of lining materials may be tested by heating small crucibles filled with slag, or by melting steel in larger crucibles made from the lining material. Microscopic examination of thin slices cut through slagged crucibles shows the nature of the slag attack.

In comparing the results obtained with different linings, account must be taken of the melting procedure and of the material melted.

The life of linings might be increased by the use of: (1) A purer or more refractory material; (2) improved grading and higher sintering temperature; (3) a more refractory bond, or the promotion of intercrystallisation, either directly or by reaction with other materials, and (4) shaped, tongued and grooved bricks which could be built into crucible form, and could be patched with cement as wear developed.

Dirty blue prints can be cleaned by rubbing with a mixture of equal parts of finely graded red rubber eraser, grated down on a medium grade file, and art gum.

Cooling solutions made from soda and water vary in strength from 1 lb. soda to 2 galls. water to 1 lb. soda to 8 galls. water. Between these extremes is satisfactory.

Factors in the Growth of Cast Iron.

In a recent issue we printed a survey on the growth of cast iron, by Mr. C. E. Pearson, under the title of "The Deterioration of Cast Iron on Repeated and Prolonged Heating."* The discussion, printed below, is interesting, as it brings to light some practical results on the behaviour of "Silal"—the non-growth iron developed by the British Cast Iron Research Association.

Speed of Heating.

MR. VICTOR STOBIE, opening the discussion, remarked that he wondered whether Mr. Pearson had given the correct title to his Paper, as some of his figures rather tended to show appreciation of cast iron on repeated heating instead of deterioration. For instance, on the stated tensile results of some cast irons which had grown in volume about 15 per cent., if the maximum stress were calculated back to the original area, it would still seem to be almost the value it was at first, and yet there was a greater volume of it! Were the tensile results taken on the original volume or the expanded volume? In some producer-gas-fired annealing furnaces of his design an interesting example of the action of repeated heating on cast iron had been noted. Cast-iron boxes, about 15 ft. long, composed of hematite iron, were used. The boxes lasted about six months, with two heatings per week to a temperature of 950 or 970 deg. C., an average of 50 heatings, and, at the end of that time, there was only a growth of 9 in. and very few cracks. It took about 12 hours to get the boxes and their contents up to full heat, which was maintained for 12 hours and then let down. The boxes were lined on the outside with 1-in. thick firebricks. It almost looked, from these facts, as if growth depended not only on the number of reheatings and the type of atmosphere but, also, in large degree, on the speed of heating. He had heard a short time ago of a turbine nozzle which, after about three months' use with superheated steam, had so changed its nature that a pencil could be pushed into it by hand. If that was a normal result of superheated steam on some cast irons, he would like to have the lecturer's opinion as to the cause.

MR. C. E. PEARSON said that he had not actually carried out any tensile tests, the figures he had given being the results of tests done by Rugan. Speaking from memory, he thought the growth tests were made on actual tensile test-pieces; they showed actually a decrease in strength of the material. The test-piece was machined to size, put through the growth treatment and then tested. With reference to the annealing boxes, 15 per cent. growth would be the volume which would be assumed from 5 per cent. growth in length, which would be a normal growth for 1 per cent. of silicon. They rarely found that their growth specimens cracked. The specimens shown on the slides were very high-silicon ones. The migration of the carbon into the steel seemed a little difficult to explain. It was possible for the carbon to pass from the iron into the steel. As to the nozzle, the late Dr. Stead had mentioned a stove back which had become completely converted owing to oxidation. They themselves had always stopped their tests as soon as the growth had ceased. The tests took something like two or three months to perform.

"Silal."

MR. PATTERSON said that in certain directions he disagreed with Mr. Pearson. The British Cast Iron Research Association had patented an iron specially for the purpose of resisting heat and scaling. The composition of that iron was distinctly high-silicon. Why Mr. Pearson had experimented with irons containing such ridiculously high total carbon as 2.5 per cent. he did not know. It seemed to him that if heat-resisting iron was required, the carbon must be reduced. The latest irons produced by the B.C.I.R.A. contained as little as 2.2 per cent. carbon with silicon from 4½ to 6 per cent. That iron was showing rather phenomenal results with regard to growth, and as he had thought they might not believe him, he had brought with him some samples. There were four samples which had been heated 200 times at a heat of 750 to 780 deg. C., one of B.C.I.R.A. iron, the second contained 3 per cent. C and 7 per cent. Si, and the third was from a Diesel liner. The B.C.I.R.A. iron sample actually contained exactly 5 per cent. silicon and either 2.2 or 2.5 per cent. total carbon. It was giving every satisfaction. In some castings which they had made for boiler-furnace work the original length was 7 in. That iron, when it came out of the furnace at the end of three months, was its original 7 in., and ordinary iron castings came out at 7½ in. long. The iron had no combined carbon whatever, it was all graphite.

MR PEARSON replied that Mr. Patterson had certainly shown them that the silicon content was not the only important thing. Of course, the B.C.I.R.A. had been working on those experiments recently, and at the time their work was done at Armstrong College low-carbon irons were not so well known as at present. It seemed really extraordinary that such a high percentage of silicon, even though the carbon was so low, would give such an extremely good result. Above 600 deg. C. he did not think the decomposition of combined carbon had much effect. He had never made tests with such low-carbon iron. At low temperatures he had had some indications that the amount of carbon had some effect on growth, but apparently he had never carried that sufficiently far. He asked Mr. Patterson whether that mixture was easily made as, for instance, ordinary iron castings.

MR. PATTERSON replied that it was somewhat difficult to handle, as it set in the ladle very quickly; it was a synthetic iron. He thought the secret of its success was due to the peculiar small granulated shape of the carbon, there being no graphite flakes in it. Its tensile strength was about 12 tons.

MR. SIMPSON suggested that perhaps it might seem that a great deal depended not only on the analysis but on the microstructure. The B.C.I.R.A. iron was practically all graphite. Might not the heat-resisting qualities be due to that? It was possible to make one iron in two entirely different ways. The solution seemed to be not so much to study analysis, except in cases of stabilising certain microstructures, as to seeing that the iron was properly melted. Dr. Mowbray had stressed to him the fact that the way in which the iron was made was of vital importance.

MR. PATTERSON agreed with Mr. Simpson, but added that the analysis was an important point. The silicon had been brought down below 4 per cent., and that had caused them a great deal of trouble. The analysis varied in sections, and if a finer grain was wanted it had to be cast in chills.

MR. PEARSON, speaking of the formation of graphite, thought that as they had assumed that growth in ordinary irons took place by the penetration of gases through long graphite flakes, if they were able to get the graphite in bulk it would take away the passages for the gases. There was some indication of that in the work of Piwowarsky on superheating, where the graphite was so distributed that long flakes were absent. In connection with the manufacture of iron, the conditions of melting with regard to the gases present in iron to begin with, Carpenter had done rather an interesting experiment. He took a piece of iron containing 6 per cent. silicon, normally giving something over 60 per cent. of growth, and heated it *in vacuo* until all the gases were removed; finally, side by side with it, he had heated an untreated piece in air. It grew very little for the first few heats, but after that it grew the 60 per cent. as the untreated piece did.

Influence of Phosphorus.

MR. C. GRESTY, after expressing his great interest in the Paper, mentioned that Mr. Pearson had not touched on the question of the influence of phosphorus on growth, which still seemed a matter of considerable controversy. It had always been the custom to use hematite iron for such castings as ingot moulds, and if, as was frequently stated, a small percentage of phosphorus was beneficial as regards heat resistance, it seemed strange that hematite iron should always be used. He would like to have Mr. Pearson's opinion on this point. In view of the results obtained in the growth tests carried out with different gases, it appeared possible that accelerated growth tests might be devised by using an atmosphere of carbon dioxide. He was also interested in Mr. Stobie's remarks about the disintegration of the cast iron of a turbine nozzle. He had seen similar cases of disintegration, or "graphitisation," as it is sometimes called, in the case of castings subjected to sea water. He had never heard of an adequate explanation of this phenomenon, but it appeared to be more a matter of corrosion than of heat.

MR. PEARSON said that he was afraid he could say nothing more about phosphorus than what he had given in his Paper, that about 0.3 per cent. of phosphorus had the effect of decreasing growth by 3 per cent. He thought it would be possible to get accelerated tests; if necessary, they took rapid tests for ordinary cast iron, and it would be possible to standardise the conditions. The actual amount of growth which took place in carbon dioxide was the same in the B.C.I.R.A. tests as in theirs; they had obtained accelerated growth. He thought that the graphitisation of cast iron took place both in clay soil and sea water, when there was a limited supply of oxygen. The heat Mr. Gresty had mentioned was perhaps due to some further oxidation taking place.

Low Carbon Content Explained.

MR. PAULIN said that the deductions he formed from Mr. Pearson's lecture were that, in selecting from what was available in ordinary irons, low-silicon irons were to be chosen, as they would keep the carbon in the combined form as far as possible. Could Mr. Pearson say whether the iron grate he had shown them on the slide had been in use in a fire in the ordinary way, or had it been simply heated in free air, and did Mr. Pearson find any difference between the growth of machined cast iron as against iron with the skin left on? The low carbon in the high-silicon iron was explained by the fact that it was a synthetic iron, whereas the irons previously used to resist growth had been carefully selected from available pig-irons, and gave the usual graphite content. This appeared to be an outstanding feature.

MR. PEARSON said that with regard to the form in which carbon existed in iron, probably Mr. Paulin had misunderstood him in the first place. Irons in which carbon was entirely in the combined form would not grow unless they had previously undergone graphitisation. Irons which had first of all been white irons and had graphitised on heating did not grow very much. He had often wondered whether there might not be a certain amount of growth when irons were malleablised. At low temperatures, of course, an iron was needed which would retain a proportion of combined carbon on heating. Commencing with an iron with a pearlitic structure, 0.7 or 0.8 per cent. combined carbon, one required to retain that after prolonged heating. The slide Mr. Paulin had mentioned had been taken from Mr. Hurst's book on cast iron, and

(*Concluded on page 354.*)

* See FOUNDRY TRADE JOURNAL of April 16, page 271, *et seq.*

XUM

Experiments with Fuel Oil in the Cupola.*

By J. R. Hyde.

In order that fuel oil, which is being largely used for heating in competition with coal and coke, may be understood, it is proposed briefly to describe what it is, and also some of its applications. The crude oil from the wells is subject to distillation, which extracts petrol, paraffin, etc., leaving a residue of high calorific value, known as fuel oil. The modern tendency is to extract more and more of the lighter products by cracking, and consequently a heavier fuel oil will be left.

The author's introduction to the use of fuel oil was soon after the Armistice, when he was able to obtain a supply of crude oil from the Government Well, near Chesterfield. This crude oil was delivered as it came from the earth, after being filtered to remove clay material, but it contained all the light oils and was a genuine crude oil—a commodity which it is practically impossible to obtain in this country. This particular oil was very low in sulphur, whereas the usual fuel oil supplied to-day is rather high in sulphur, due to the distillation process, which unfortunately leaves the sulphur in the fuel oil. The experiments seemed to have a reasonable cash basis, because the calorific value of oil is roughly 18,000 B.T.U. against coke's 10,000 B.T.U., and, therefore, with foundry coke at 38s. per ton, fuel oil seemed reasonable at 70s. per ton.

The author then described several modern oil burners, such as are used for burning fuel oil in various industrial furnaces—boilers, metal melting, annealing, billet heating, etc., in order to contrast the conditions in the cupola with these recognised commercial applications. Where a chimney draft is available, as it is in the case of boilers and furnaces, air can be admitted around the furnace for combustion, and the primary air admitted through the burner is then mainly for atomising the oil.

The Oil-Fired Cupola.

The application of an oil burner to the foundry cupola was first suggested, and a system patented and used, by Bradley Stoughton, of Bethlehem, U.S.A., in 1914, and Papers were published in "Transactions" of the American Foundrymen's Association from 1915-1918, that is to say, during the war; other people were experimenting along similar lines. It was realised that it was impossible to use the cupola without coke, because coke had the advantage of localising the heat by keeping the charges apart, and at the same time enabled the products of combustion to escape through the cupola stack.

The particular cupola used was of the ordinary type with two rows of tuyeres, three tuyeres in a row, and the upper 8 in. above the lower. To the upper, or supplementary, tuyeres an atomising burner which sprayed fuel oil into the cupola was introduced, and reliance was placed on the main blast of air to complete the combustion. Where a chimney draft is available, it is permissible to atomise the oil with part of the air supplied only, and in the author's case he used high-pressure air at 20 lbs. per sq. in., which did this work quite effectively. The cupola was charged as usual with the full amount of *bed coke*, and this bed, of course, was kept red hot all the time in the usual manner, but it was contended theoretically that if oil was supplied to be burned with the air, the oil would be burned and the coke last much longer.

The charges of coke were reduced by half the usual weight, so that instead of putting 2 cwts. of coke between the charges, only 1 cwt. was added, and reliance was placed upon the fuel oil to supply the rest of the heat. The amount of oil was 60 lbs. weight, or 6 galls., and it was checked by marking the fuel tank conveniently. A head of 12 ft. was employed. The melting was found to be rather quicker than when using coke, and considerably less slag was formed. The slag was always fluid, and readily flowed from the cupola.

It was not found advisable to reduce the quantity of coke below 50 per cent. of the original amount, and it was further found that only the very best coke would stand up to requirements. A further experiment was to bring the oil burner opposite the main air tuyeres, which were kept on the large side, and by using the burner in this position it was possible to keep the tuyeres very bright and always open, but the wear on the lining just inside the tuyere was severe, so that when using the oil burner in this position the oil supply was cut down very considerably, and melting was slower than previously.

The following specimen charges indicate how working conditions were modified when melting under these conditions.

All coke melting	2 cwts. coke	16 cwts. pig and scrap
Oil	1 cwt.	" " " "
	6 *galls. or* 60 lbs. oil	" " " "

Oil melting seemed to result in rather a high melting zone, but at the same time it gave a very clear melt right through to the last charges of the cupola, and the size of the dump after a day's work was distinctly reduced. At the same time, the metal was quite hot and fluid from the cupola.

When the time came to take stock of the position for and against the use of oil, it was found that the favourable factors were: (1) Slightly lower sulphur content (0.050 per cent. as against 0.055 per cent. with coke firing); (2) hotter metal; and (3) cleaner and less dump. Against the system the following items were noted: (1) Extra air service at 20 lbs. per sq. in.; (2) extra cost of fuel; (3) extra trouble to regulate; and (4) waste due to high percentage of CO in the escaping cupola gases.

It will, of course, be realised that a considerable amount of work has been done in America in connection with the use of oil in cupolas, and several writers have contributed articles on the subject. They all, however, found that there is little advantage from a cash point of view, and so far as the sulphur is concerned, probably when this came to be investigated carefully, it would be found that it meant a very careful check of the fuel oil received in order to keep the sulphur in reasonable limits. This led to an investigation as to the sulphur content of the various fuel oils on the market, and the percentages were returned in the order shown in Table I.

TABLE I.—*Sulphur Content of Various Grades of Fuel Oil.*

Source.	S content, per cent.
Borneo	0.1 and less.
Russia	0.3 "
Chesterfield or Hardstoft	0.4 "
American Diesel	1.0 "
70 secs. Fuel	1.5 "
Persia	1.7 "
Mexico	3.2 "

Four or five years ago the author found that he was ploughing a lone furrow in demanding low-sulphur content in fuel oil, and, although the position has been improved in the last two years, he does not consider that there is any commercial advantage in using a crude oil in the cupola in the manner illustrated.

In order to account for the peculiar lack of efficiency, it was found that the presence of CO in a flue gas is fatal to good combustion of oil, and, as is well known, it is almost impossible to get any part of a cupola stack above the tuyeres, where there is not a very considerable percentage of CO. Also, oil is best burned in very open space, which is the reverse of cupola conditions.

It is believed that the following statement is correct. No great improvement in melting conditions or in the composition of the liquid pig-iron was obtained, and, although the conditions created a most interesting time from an experimental standpoint, the commercial side does not show any saving. The author is indebted to the British Cast Iron Research Association and to Messrs. Alldays & Onions for cupola particulars, and to Messrs. Shell Mex and Manchester Furnaces, Limited, for details of the oil burnt.

* A Paper read before the Sheffield Branch of the Institute of British Foundrymen.

Factors in the Growth of Cast Iron.

(*Concluded from page* 353.)

he had no idea of the conditions under which the grate had been heated. From the form of the bars, however, he did not think there was any question of their having been bent through use, and not mechanically. He had not taken any tests with the skin on, and he had not the least idea whether it would make any difference in the amount of growth. With regard to the steel casting, were any measurements made of the outside diameter?

Mr. Paulin replied that no such measurements were taken, it was a case of internal stresses in casting.

Mr. Pearson said that in connection with that, tests had been made on steel bars which had been heated for long periods, and the tendency was to reduce in length and to increase in diameter. They showed signs of becoming spherical.

Mr. Logan, referring to Mr. Simpson's question of the different methods of making the same iron, asked whether growth could be expected to be the same in both cases, taking both composition and structure as factors. He also asked why there was a difference in growth when iron was heated at high and low temperatures.

Mr. Pearson said that, regarding Mr. Logan's first question, he could only say that Carpenter's series of irons, which were crucible cast irons, he believed, and those which they had used themselves, ordinary commercial cast irons, had given the same curves on the graphs of the tests. There they had very different methods of preparation, but the same growth. With regard to repeated heating and cooling, it seemed to be necessary at high temperatures owing to the closing up of passages along which the gases could pass. At low temperatures the amount of growth was very much smaller, and it appeared to be chiefly due to the increase in volume brought about by the decomposition of combined carbon, and that, of course, was not dependent on repeated heating and cooling.

Mr. Pearson briefly replied to a vote of thanks, which was proposed by Mr. Paulin and seconded by Mr. Gresty.

Workshop Slogans.

Mr. Jas. Nicholson, foreman patternmaker, Messrs. Cruikshank & Company, Limited, Ironfounders, Denny, Scotland, has sent us two sketches he has prepared as a basis for a poster, the message of which is "Moulders encourage the apprentices." This represents a system established at the works for the psychological instruction of the employees by posters carrying trenchant messages. We can see great possibilities in the scheme, even though we inherently detest slogans, as they generally tend to convince people without giving them a background of logic. However, we have no grumble with the following examples: "Perhaps your idea is best, let's have it"; "Competition is keen. Give us of your best."

Recent Developments in Special Cast Iron.*

By A. B. Everest, Ph.D.

Cast iron consists essentially of an alloy of iron and carbon, containing by definition over 2 per cent. of the latter element. The carbon in the iron may be present either in the combined form or as free graphite, the one form changing to the other in accordance with the simple reversible chemical reaction $Fe_3C \rightleftharpoons 3\,Fe+C$. It is well known that in the pure iron-carbon alloys carbon is present all in the combined form. The presence of other elements, however, renders the combined form more or less unstable, with the result that a balance is struck between the amounts of combined and free carbon present in the iron. Excess of combined carbon gives a hard iron with a tendency to a white structure, while the complete absence of combined carbon gives a soft, and often open, grey-iron structure.

In considering the relationship between the ordinary elements found in commercial cast iron and also of any added elements and the above reaction, it is found that silicon, nickel, copper, aluminium and cobalt tend to the formation of free carbon, whilst molybdenum, manganese, silicon, chromium and, under some conditions, phosphorus, all tend to the retention of the carbon in the combined form.

It is a matter of common experience that as increasing amounts of one of the softening elements, that is a graphite-forming element, are added to cast iron the proportion of graphite to combined carbon does not change in direct relationship to the amount of added element, but a relatively stable condition in the iron is found when the combined carbon is between 0.5 and 0.7 per cent. as shown in the curve, Fig. 1. This curve emphasises that the pearlitic condition in cast iron is a stable one and persists over a wide range of composition.

The chemical reaction mentioned above, in common with all other chemical reactions, takes time to reach a balance or to attain completion. For practical purposes it is useful to regard all the carbon in molten cast iron as in the combined condition. Given that there is a tendency, as a result of composition, to the formation of graphite from the carbide, then the cooling rate of the iron is of vital importance in determining the degree to which this tendency can have effect. Thus, even in an iron of high silicon content, rapid cooling will generally cause the retention of a large proportion of the carbon in the combined form and the iron is therefore said to be chilled. If, accordingly, the curve combining cooling rate and combined carbon is drawn, it is found that once again this curve has the same form as that found from a consideration of composition and combined carbon and the two curves can be used to demonstrate the same features as shown in Fig. 1.

It is accordingly evident that the pearlitic or stable range in grey cast iron is persistent, not only over a wide range of composition but is also the stable condition over a wide range of cooling rate and it is a matter of practical experience that the pearlitic condition is the natural condition in castings with normal compositions and section thicknesses. It is further emphasised in this connection that the pearlitic condition in commercial cast iron is that associated with the best mechanical properties from the strength, wearing quality and shock resistance points of view.

Limitations of Cast Iron.

In considering the limitations of cast iron it must be stressed that cast iron, in spite of its limitations, is a material of valuable engineering quality; its resistance to wear, its rigidity and its resistance to corrosion being points worthy of special attention in this connection. The limitations of cast iron, however, are principally its lack of strength resultant from the breaking up of its structure by flakes of free graphite, and secondly, the variability of structure which results from variation in cooling rate, and which, in turn, is generally the result of varying section thickness.

Dealing first with the strength limitation, the growth of large coarse graphite flakes in cast iron detracts very seriously from its mechanical strength. The growth of such flakes is dependent firstly on a large total-carbon content in the iron which results in the presence of excessive carbon, both in the combined and graphitic form, and secondly, on a series of conditions which result in the formation and growth of coarse graphite flakes from the carbon, initially in the combined form.

Control in Melting Operations.

Recent developments in cast-iron practice have been directed towards the elimination of high total-carbon content by special control in the melting operation. The cupola method of melting cast iron, while very economic, has in the past suffered from the limitation that a heavy carbon pick-up was involved, so that even with steel mixtures the total carbon in the final castings was frequently on the high side. This trouble has, to a great extent, been minimised by study and development in cupola design, so that the melting conditions have been improved to give metal with lower total-carbon contents and to-day it is common practice to use the cupola for the production of cast iron with less than 3 per cent. total carbon. For high-grade work, however, there has been a tendency to turn from the cupola to methods of melting in which the fuel is not in direct contact with the charge. For small quantities of special metal, crucible melting has been used a great deal in the past, but is for most purposes not generally an economic proposition. Air-furnace melting has also been used for many special applications. More recently, however, the principles of the air furnace have been adapted in the rotary furnace, in which the heat absorbed by the furnace roof is carried actually under the bath by the rotation of the furnace on a horizontal axis. Electric furnaces have also been used for the melting of cast iron and have proved economic where an abundant and cheap electric supply is available.

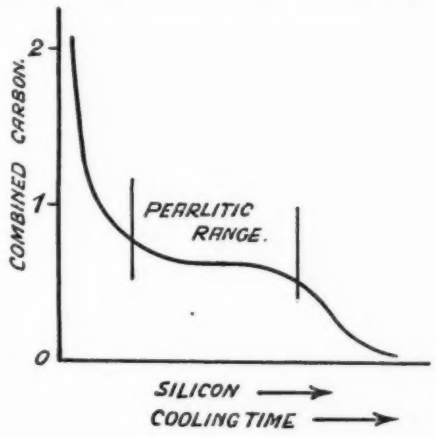


FIG. 1.

Modified cupola processes are also available in which carbon pick-up is minimised by coating the coke used with a suitable material, such as lime, so as to limit its reactivity in the smelting zones in the furnace, as in the Corsalli process.

Other Recent Developments.

Apart from the question of total-carbon content in the iron, the finer form of graphite is appreciably effected by other influences such as, for example, superheating the metal in the furnace. Piwowarsky and others have demonstrated that the superheating of molten cast iron results in a finer form of graphite, with generally a higher combined carbon in the final casting. A further process of growing interest to-day is one in which a charge containing a large proportion of steel is melted down and tapped from the furnace, the necessary softening elements being added in the ladle. In this process it is found that, by adding the requisite amount of material to the ladle of metal, a very fine form of graphite is produced, which, of course, results in improved mechanical properties in the castings. Still a further process, due to Schutz, depends on the use of an iron in which excess of softening element, such as silicon, is employed, and the molten metal is then cast under conditions inducing very rapid cooling, as, for example, by casting into chills. The high proportion of softening element prevents the formation of carbide, and a fine form of graphite is obtained.

These processes, all of which tend to the elimination of the growth and size of graphite flakes, are not for the most part successful in eliminating the time factor in the growth of graphite, with the result that once again, in a casting of varying section thicknesses, a wide variation of structure is likely to be met as between thin and thick sections. This variation of structure is a serious limitation in iron castings, since it tends to result in the formation of hard unmachinable structures in the thinner sections of the casting, whilst, at the same time, the thick sections will frequently show an open coarse-grained and frequently porous condition, the last of these being accentuated by the fact that the harder metal in the thin section shows a heavier contraction on solidification than does the softer metal, with resultant draining away of metal from the heavier and more slowly-cooling parts.

Hot-Mould Process.

Processes have been evolved which aim, in effect, to equalise the cooling rate in different sections of the casting, hence, to do away with this variation in structure. The simplest of these, and one which is in everyday use, is the application of chills and denseners to the heavier parts of the casting, which, by their action in abstracting heat from the molten metal more rapidly than can the normal sand face, cause a rapid cooling in their neighbourhood, with a consequent hardening and densening of the metal. A further process well known to-day is that worked under the name of "Perlit," in which the reverse of the above is employed. A hard grade of iron is used, and this is cast into a heated mould, and, although complete equalisation of cooling rate cannot be obtained by heating the whole mould to a uniform temperature, nevertheless, the effect of the whole process in retarding solidification of the metal is to give a very uniform structure throughout the casting.

A further limitation of cast iron which is closely related to the breakdown of the combined carbon dealt with above is found in its reaction to the effects of prolonged or fluctuating heat. The effect of slow cooling in inducing a large grain growth and coarse graphite form has been emphasised. These effects are not essentially the result of slow cooling from the molten condition, but can be obtained by heating up a casting or subjecting it to fluctuating temperature, when the process of carbide breakdown, which proceeded to a certain extent during the cooling of the casting, will be able to proceed with a

D

* Summary of a Paper given at Loughborough before the East Midlands Branch of the Institute of British Foundrymen, Mr. T. Goodwin presiding.

consequent complete change in the structure of the iron. Furthermore, as grain growth proceeds in the solid metal, the structure tends to open up, and, in an oxidising atmosphere, internal oxidation of the metal takes place, with the result that the metal grows in size and loses its strength and other properties. This phenomenon is well known under the name of "growth."

Use of Alloy Additions.

Much information had been published in the past few years on the history and development of alloy additions in cast iron, and a review of the situation to-day clearly shows that nickel and chromium have become well established as special additions, for the purpose of equalising the structure and giving greater uniformity, hardness and strength throughout castings of varying section. The necessity of maintaining a correct carbide to graphite ratio cannot be over-stressed, and it must be remembered that nickel additions of themselves are not always the most useful, but that a combination of nickel with a silicon reduction, or of nickel and chromium together, were the most generally effective. For increasing density, pressure tightness and strength, the former combination is most generally favoured, whilst for improved wearing quality and improving strength in low-silicon irons, the nickel-chromium addition is probably the more useful.

Much work has been published recently on the effects of other additions of alloys, including not only nickel and chromium, but also copper, molybdenum, aluminium, etc., and combinations of these. Less has been said, however, concerning the cast irons produced by the use of higher alloy additions, and the rest of the Paper is devoted to a consideration of the special properties with which cast iron can be endowed to-day as a result of the higher proportions of added elements.

Referring first to higher additions of nickel, it had been shown in previous work that additions of nickel up to 4 per cent. served generally to bring about a more or less definite modification of the structure normally associated with cast iron. Above 4 per cent. of nickel, however, it was found that cast irons were produced which, whilst grey in structure and showing on analysis a normal proportion of graphitic carbon, were yet hard and increasingly unmachinable. These effects depend on the fact that the combined carbon in the iron, which would be normally pearlitic in structure and therefore readily machinable, in the presence of the higher alloy additions becomes first sorbitic and then martensitic, endowing the matrix of the iron with the properties of hardened tool steel. The maximum hardness in a cast iron with nickel additions is generally obtained between 7 and 10 per cent.; above the higher limit the irons become gradually softer again and at about 18 or 20 per cent. of nickel the irons will be still grey, and are very soft indeed and readily machinable. In this latter condition the irons are not normal and show as peculiarities a very marked resistance to corrosion and chemical attack. They are also heat resistant and also show the peculiarity of being non-magnetic, all of which depend on the fact that the matrix of the iron is in the austenitic condition.

Martensitic Cast Iron.

Whilst initially it was realised that the special properties of the austenitic cast irons were of commercial interest and would be the subject of development, nevertheless it was felt that the intermediate martensitic ranges would not be of any commercial interest. This forecast has, however, proved wrong. The demand for materials of improved wearing quality, especially in connection with automobile work, has led investigators to study the properties of a large number of the more newly available materials. Amongst these attention has been given to the martensitic cast irons and castings, for various parts have been made with a nickel content of about 6 per cent. Castings in this material could be machined with a Widia tool-steel, and it was found quite a practical proposition to machine and grind the castings to the desired shape and dimensions. This material in service showed extraordinary good wearing quality; for example, in cylinder liners in use on commercial vehicles negligible wear was reported after a run of 50,000 miles.

It was realised, however, that this material, whilst of excellent quality, was subject to the serious limitation that it was not in general easily-machined, even with the special steel, and it was not long before attention was given to the possibility of subjecting cast iron, as in the case of steel, to a heat-treatment which would confer the desired hardness after the machining operations had been performed. Study in this direction has resulted now in the production of cast irons which can be cast in the grey and machinable condition, and which, after rough machining, can then be hardened by a simple oil quench before grinding to final dimensions. The possibility of heat-treating cast iron is not new, and it is not dependent essentially on the use of alloy additions. In the case of ordinary cast iron, however, it was the experience of manufacturers that excessive warping, distortion, and even cracking, resulted on account of the necessity for drastic heat-treatment in order to obtain the desired result.

The addition of nickel to an iron-carbon alloy, whether it be a steel or a cast iron, effects a lowering of the critical points on which heat-treatment depends, so that they are brought progressively nearer to room temperature. It has been shown that an iron with 6 per cent. of nickel will be martensitic in the "as cast" condition. With a slightly lower percentage of nickel, a structure bordering on the martensitic, but yet fully machinable, may be obtained. This material will, in accordance with the above generalisation, have had its critical points depressed, and, as a consequence, it is found that the part may be heat-treated and rendered martensitic by a simple quench under conditions much less drastic than those required in the case of ordinary cast iron. This less drastic heat-treatment at once benefits the manufacturer in minimising the trouble previously experienced with warpage and distortion.

Heat-Treated Cast Iron.

Nickel of itself tends towards the production of graphite from carbide; consequently there is a tendency in the irons with the higher proportions of nickel to show rather more graphitisation than desirable. The graphitising influence of nickel can always be counteracted by the addition of chromium, and consequently, in the natural evolution of heat-treatable cast irons, it is found to-day that nickel and chromium are combined together, the chromium to maintain the combined carbon in the iron to the maximum useful extent, whilst the nickel is added to render the combined carbon in the martensitic condition, either before or after heat-treatment. Some compositions of heat-treatable cast iron have recently been patented[1], but these are only typical of a number of alternative compositions which can be used to attain the same end.

In a recent paper, Hurst[2] has published some figures which he has obtained illustrating the mechanical properties of heat-treated alloy cast irons. He shows, for example, that an iron with 2.5 per cent. of nickel and 1.0 per cent. of chromium, on oil-hardening from 850 deg. C., will develop a Brinell hardness of about 470. A feature of his work, however, is that he demonstrates that, under these conditions, the tensile strength of the iron is seriously affected, and after oil-hardening the strength falls from 24½ tons per sq. in. to about 15 tons per sq. in. Hurst studied the effect of tempering the hardened cast iron, and has shown that by tempering a hardened casting at about 300 deg. C. the Brinell hardness falls slightly to about 420, whilst the tensile strength is restored and reaches 23 tons per sq. in. Further tempering gave even a greater increase in tensile strength, with only a relatively small loss in hardness, and maximum strength is shown by an iron with nearly 25 tons per sq. in. and a Brinell hardness of about 380, a combination of properties which until recently would be regarded as unique in cast-iron practice. It would accordingly appear from Hurst's work that to obtain the maximum benefit from a combination of heat-treatment and alloying in cast iron, quenching followed by tempering is necessary, in order to achieve the best results, exactly as in the case of steel. This work opens up a vast field of possible future development for heat-treated castings where high strength and hardness, together with good wearing-quality, are required.

Chilled Castings.

A further application of the martensitic or hard cast iron which is of special interest is in the use of alloy cast irons for chilled castings. It has been found that, where the white iron structure in a casting is maintained by chilling, then the addition of nickel and chromium give further increase in hardness, in that they produce their usual effect in rendering the combined carbon first sorbitic and then martensitic. This feature is proving of special interest in connection with such applications as chilled rolls where it is found that nickel and chromium, in a fixed ratio of 3 to 1, do not have any marked effect in altering the depth of chill shown by the iron, but they do have a marked effect in hardening the chilled iron structure and, at the same time, rendering the interior or core of the roll itself tougher and harder. The addition of nickel and chromium in the fixed ratio as mentioned above, results in a progressive hardening in the surface of the roll; in passing, it is interesting to note that additions of over 2 per cent. of nickel have been the subject of a British Patent.[3] Vast fields of future development are, however, opened up by the possibility of developing hardnesses in cast iron, which are nearly as great as those obtained in the case of hardened steel.

Austenitic Cast iron.

It has already been mentioned that the higher additions of nickel give an austenitic structure in cast iron which is corrosion-resistant, non-magnetic and more recently has been found to be very useful as a heat-resisting material. Whilst these properties can be obtained in the iron by the addition of nickel alone, it has generally been found for economic and other reasons, that it is desirable to modify the composition by the addition of other metals, as a result of which the nickel content has been appreciably reduced. Thus, for example, in the case of "Nomag," which has been developed as a non-magnetic cast iron, a proportion of manganese is used in place of part of the nickel. Again in the case of "Nimol," which has been developed on account of its corrosion and heat-resisting qualities, copper is used in place of a part of the nickel content. These cast irons are found to possess a matrix similar in properties to the stainless steels and, as a result, are remarkably useful in applications where they are subjected to chemical attack. The irons are also found of special application in heat resistance. Material of this class, which can be produced at an economic price, has certain special applications which assure for it a rapid development and a useful future.

In conclusion, a passing reference must be made to some of the other special cast irons

1 Brit Pats. 342,334, 342,335.

2 J. E. Hurst. "Oil-Hardening and Air-Hardening Cast Iron." Foundry Trade Journal, 1930, Vol. 43, pp. 385, 400, 437.

3 Brit. Pat. 279,414.

which are being developed to-day, especially those produced by the addition of silicon which, in the range of about 13 per cent., has been used for some time for special corrosion-resisting castings, whilst more recently the B.C.I.R.A. has taken out a patent[4] covering intermediate ranges of silicon to give irons showing a very useful heat-resistance.

DISCUSSION.

Mr. T. Goodwin (Loughborough), Branch-President, in opening the discussion thanked Dr. Everest for his most interesting and enlightening Paper and commented on the wealth of detail which was given. He had, however, some points to criticise and mentioned in the first place that Dr. Everest had referred to the use of nickel in eliminating porosity in piston castings. In his own work he (Mr. Goodwin) had met this trouble of obtaining sound piston castings but had found that by judicious control in the foundry it had been readily possible to obtain consistently good results without the use of any expensive additions. Mr. Goodwin next referred to phosphorus content in high quality cast iron and commented on the fact that several of the analyses shown on the slides gave a low phosphorus content. Mr. Goodwin asked if this was necessary in using alloy additions. Referring to the question of making nickel additions to cast iron, the speaker reported that the general experience seemed to be that it was not possible in making the addition easily to arrive at a given analysis, and that in some cases where nickel had been added no nickel was found in the resulting castings. He wished to ask Dr. Everest whether he could confirm this experience.

Low-Carbon Cast Iron.

Mr. Goodwin next referred to the question of carbon reduction in the production of high-duty cast iron. He criticised Dr. Everest's statement that on proper cupola control, and using a steel mixture, the carbon pick-up would be such that at least 3 per cent. would generally be expected in the final castings. He reported that in his own work he was consistently running a heavy steel charge through the cupola and by proper control was obtaining carbons very much less than this figure and that he thought Dr. Everest's statement was therefore inaccurate and required amendment.

Nickel in Malleable Iron.

Mr. A. E. Pease (Derby) also complimented Dr. Everest on his Paper and indicated that he had enjoyed the evening very much. There were a few points, however, which he would like to raise but, in the first place, he wished to endorse all that the lecturer had said with regard to alloy additions. One point, however, he felt the author had not perhaps sufficiently stressed was the fact that nickel additions cannot be recommended to make a bad iron good, but that under proper conditions, their use was always towards giving further improvement to an iron which was already of good quality.

Referring to the question of the heat-treatment of cast iron in order to give high hardness and strength, Mr. Pease asked whether there was not during heat-treatment a danger of growth in the castings, since it occurred to him that under the conditions of heat-treatment there might be a danger of carbide decomposition and of oxidation. He next asked if the author could give any information concerning the casting qualities of alloy cast iron generally, having special reference to cast iron with small additions of nickel and also to the cast iron in which sufficient alloy addition had been used to render the iron austenitic.

Mr. Pease's next query dealt with the question of malleable cast iron, and he asked if any information was available on the influence of small additions of alloys in malleable castings, and whether any improvement should result from the influence of alloys.

Linked up with the question of the influence of nickel with graphite formation Mr. Pease inquired whether Dr. Everest could give any information as to the reason for the influence of nickel in refining the grain and giving a greater uniformity in iron castings, that is to say, whether Dr. Everest could put forward any fundamental feature of the action on cast iron which would explain these peculiarities.

Loss in Nickel Additions.

Mr. P. A. Russell (Leicester) said that he heartily endorsed all that Dr. Everest had said with regard to alloy additions. He had had some experience and had carried out some experiments, as a result of which he felt that he was a staunch ally of the author. He wished to ask the author if he could give any information on a suitable test for measuring the wearing quality of cast iron, as he was very interested in this point and would be glad to hear if there was any means of measuring wear, other than a service test.

Referring to the question of making up austenitic cast iron, he would be glad to hear if this material was covered by patent or whether anyone could make up this class of casting. Referring to the question of the analysis of alloy cast iron, he confirmed that he had met some difficulty in obtaining an exact analysis on making the alloy additions, but he thought this was probably due to ordinary foundry difficulty in making full allowance for scrap returns, the amount of metal in the ladle, etc. In this connection he inquired what were the relative merits of making the alloy additions either in the cupola or in the ladle, and he asked further if the author would recommend the use of a cupolette for running the special cast iron required in connection with castings to contain a percentage of nickel.

He referred also to the point raised by Mr. Pease with regard to the fundamental influence of nickel and indicated that, although he was satisfied that nickel did all that was claimed for it, he could not understand why the nickel additions should have the beneficial effect which they undoubtedly did.

High Casting Temperature and Chill.

Mr. H. Bunting (Derby) referred to the fact that Dr. Everest had mentioned the influence of cooling rate on the retention of combined carbon and had indicated that, the more rapid the cooling rate, the harder the product. He mentioned that he had an interesting example in having found recently a case in which casting the metal from a higher temperature resulted in the production of a greater depth of chill in the final casting which would seem, if anything, to be somewhat opposed to Dr. Everest's remarks, since the hotter metal would cool more slowly through the critical ranges of temperature and therefore should show a greater proportion of graphite.

Distortion through Heat-Treatment.

Mr. J. F. Driver (Loughborough) referred to the question of heat-treating castings and inquired whether heat-treatment was not liable to lead to distortion and cracking. Continuing, he mentioned that he noted that Dr. Everest had quoted a figure for shore hardness on a chilled cast-iron roll. He criticised the use of the Shore hardness test for cast iron of any sort, owing to the fact that the hardness measured was purely local and on a very small area. He indicated that he did not see that the Shore test could give a just measure of hardness, having in mind the heterogeneous nature of cast iron.

He inquired whether it was possible for additions of nickel to cast iron to produce castings having high magnetic permeability, as in the case of the straight nickel iron alloys. He had read the literature recently and had been interested in the possibility of obtaining very high magnetic permeability in alloys containing about 60 or more per cent. of nickel, and it occurred to him that it might be possible to make a cast iron with nickel additions which would be of great use on account of its magnetic quality.

Mr. J. Lucas (Loughborough) criticised the various analyses which Dr. Everest had given for high-quality cast iron. He inquired how it could be an economic proposition to consider the use of cast iron containing 0.2 per cent. of phosphorus or so, whilst they in that district were faced all the time with local pig-irons which contained phosphorus up to 1.5 per cent. or more. It was clear that even by the use of steel scrap the local pig-iron could not be used for obtaining the low-phosphorus figure indicated. Mr. Lucas asked Dr. Everest whether it was essential to maintain phosphorus at this low figure, although he appreciated that Dr. Everest had stressed the fact that, in order to obtain maximum strength and resistance to shock, phosphorus should be maintained at a low figure.

Corrosion-Resisting Cast Iron.

Mr. Honeymore inquired of the corrosion-resisting properties of nickel cast iron. He indicated that he had used ordinary cast iron in connection with handling strong sulphuric acid. The service given by the cast iron was, naturally, not great, and he had heard that the special cast iron known as "Nimol" could be used for this application. He asked for further information on this point, as he was interested at the present time in the production of some castings which were in the form of pots and were required to hold 6 cwts. of strong sulphuric acid.

He had another problem in connection with a box casting in which trouble had been experienced with blow-holes in the casting wall. He inquired if nickel would be useful in eliminating this type of trouble.

AUTHOR'S REPLY.

Dr. Everest, replying to the discussion, thanked the various speakers for their appreciative remarks. Referring to the points raised by Mr. Goodwin, he wished, in the first place, to make it quite clear that in castings such as pistons, nickel was not put forward as the only means of achieving success in a difficult design. It was known that satisfactory results could be obtained by many other methods, but, to quote a definite example, a case had recently come to light in which trouble with porosity in piston bosses had been occurring. The manufacturer announced triumphantly that, after two years' research work on methods of casting, composition, moulding sands, etc., he had been able to overcome his troubles and was obtaining consistently good results. Dr. Everest said the message which he wished to convey was that nickel, in virtue of its action in conferring a greater latitude on cast iron, frequently gave a short cut to success in the case of castings such as those described, and where a firm was in trouble with porosity, then nickel was generally an immediate cure, having due regard to the proper adjustment of composition of the iron. He fully appreciated Mr. Goodwin's remarks that it had been possible, by full control in the foundry, to obtain consistently good results without using special additions.

Low-Phosphorus Irons and Strength.

Referring to the question of phosphorus, a point which had been touched on by many of the speakers, Dr. Everest indicated that he would not suggest that nickel was useless in a high-phosphorus iron, but he rather wished to convey that, for maximum strength and quality in any cast iron, with or without alloy additions, he personally preferred to see the phosphorus on the low side, and he was convinced that, for maximum tensile strength and resistance to shock, low phosphorus—that is to say, phosphorus at least under 0.5—was essential. It was because, in experimental work, the author had

[4] Brit. Pat. 323,076.

XUM

been using high-grade cast iron of this type, that most of the analyses shown on the slides gave a low-phosphorus content. Nickel had its usual effects in irons of higher phosphorus, and, consequently, there was no suggestion that low phosphorus was essential to the success of alloy additions.

Nickel Loss should be Negligible.

Dealing with the question of arriving at a given analysis, the lecturer expressed surprise that Mr. Goodwin had met difficulty in this direction, since his own experience, which was a reflection of the experience of a very large number of expert foundrymen in the country, was that nickel was one of the easiest metals to control when used in a suitable form, being readily dissolved and never lost by oxidation. By proper calculation in making the alloy addition, it was, consequently, possible to arrive within very close limits of the desired analysis. If no nickel was found in the castings after an addition had been made, then the only suggestion which the lecturer could make was that perhaps an unsuitable form of nickel had been used, as a result of which the nickel had not been dissolved. This question had, however, been adequately dealt with elsewhere, and suitable forms of nickel were readily available which could be added in the proportions normally employed directly even to cold iron in the foundry.

Carbon Pick-up in Cupola Practice.

Referring to carbon pick-up, Dr. Everest confirmed that it was his opinion that even under controlled cupola working, it was abnormal to obtain a carbon below 3.0 per cent., but he was aware that, in some special cases, steel mixtures were regularly worked to produce a carbon of 2.9 per cent. He was surprised to hear that under ordinary cupola conditions Mr. Goodwin was able to get a carbon substantially less than 3 per cent., since he believed that in melting by any conditions it was found generally that 2.8 per cent. was an absolute minimum, since below this special casting difficulties were involved.

Replying to Mr. Pease, Dr. Everest thanked Mr. Pease for stressing the fact that nickel additions are not recommended to make a bad iron good, but that the nickel additions are most useful in adding extra quality to an iron already of good properties. Dr. Everest indicated that he had intended to stress this point, but it had, at the moment, slipped his mind.

Heat-Treatment and Growth.

Referring to the question of growth during heat-treatment, Dr. Everest indicated that the actual time of heating was so small that, under standard conditions, he did not think there was any danger of growth during the heat-treating operation. Carbide decomposition was not likely to take place provided the iron was heated to above the critical range and then immediately quenched out.

Referring to the question of casting quality, Dr. Everest indicated that it was general experience that the addition of nickel, and of alloys generally, to cast iron did not have any deleterious effect on the casting quality of the metal—in fact, it might be argued that the actual casting quality of the metal was improved, since the addition of nickel in the ladle would undoubtedly cause some chilling of the metal, but after this it was found that the metal cast as well as if it were at the original temperature.

Austenitic Cast Iron.

With regard to austenitic cast irons—that is, those containing higher percentages of nickel—the author could not speak from experience with regard to their casting qualities, but indicated that the austenitic cast irons were regularly cast with every success, so that, if there were any minor defects, they were certainly not insuperable.

Nickel in Malleable Iron.

Referring to the question of nickel in malleable cast iron, the author indicated that many experiments had been carried out, but so many variables were involved that no definite conclusion had been reached. In some cases some advantage was apparent, but this had not definitely been confirmed.

In making alloy additions to malleable, it was clearly essential to control the addition so that the raw castings were completely white and that primary graphitisation did not commence. Given that condition, then it was possible that, by the use of alloys the formation of secondary graphite might be modified with a beneficial result provided the current set of conditions could be obtained.

Referring to the influence of nickel on refining the grain and graphite structure, the author indicated that he could not give any particular reason for the controlling influence of nickel. It was possible that the control of nickel on the freezing range might possibly have some influence, and then, again, the question of the influence of nickel on the critical ranges would undoubtedly have some effect.

Accelerated Wear Tests.

Dr. Everest thanked Mr. Russell for his support and was glad to find that this speaker had had experience which confirmed the author's remarks. Referring to the question of wear tests, the author indicated that he was convinced, after much experience, that there was no satisfactorily rapid test for the measurement of the wearing quality of cast iron, since it was impossible ever to reproduce the exact conditions of service running and, at the same time, to obtain accelerated results. The only satisfactory test was a service test or, perhaps, a bench test under load.

Referring to methods of making the alloy additions, the author indicated that cupola additions were preferred to ladle additions, especially where a large quantity of metal was required. Ladle additions were convenient when making a small quantity of the alloy cast iron. Referring to the use of a cupolette, the author indicated that he had not very much experience in this direction, but he had found that, where a cupolette was used for desultory experiments, insufficient control was usually obtained and excessive carbon pick-up was frequently found.

Dr. Everest, replying to Mr. Bunting, expressed his interest in the example quoted in which a higher combined carbon had been obtained when casting from a higher temperature. He knew that this result was frequently obtained, but would not attempt to explain it. In this connection he wished to stress that the simple theory given in the earlier part of the Paper, although useful as a first approximation, could not be held to be complete or, for that matter, fully justified in detail in practice.

Modified Heat-Treatment Inhibits Distortion.

Replying to Mr. Driver, the author explained that, in the heat-treatment of castings, it had been the experience of many workers that, in ordinary cast iron, distortion and cracking were liable to occur owing to the drastic conditions necessary to obtain a given result. The whole point the author wished to make was that the use of alloys, such as nickel and chromium, so modified the heat-treatment necessary to produce this result that the danger of distortion and cracking was largely minimised, if not completely eliminated.

Referring to the question of Shore hardness on rolls, the author felt that the best way he could answer Mr. Driver's criticism was by referring to the fact that it was the standard practice in the roll trade to purchase rolls to a specification of Shore hardness on the surface.

Referring to the question of castings with high magnetic-permeability, the author indicated that this was a point which had not occurred to him. He indicated, however, that he did not think that there was anything in the suggestion, since the high-permeability nickel-iron alloys depended to a large extent for their properties on workability and subsequent heat-treatment. Clearly, cast iron could not be handled in this same manner. Reference had been made to "Nomag" as a magnetic material, but the author was not confident that it would be easy to develop a highly-magnetic cast iron with properties anything approaching those of the pure nickel-iron alloys.

Acid-Resisting Castings.

Referring to Mr. Honeymore's inquiry, the author indicated that the special cast iron known as "Nimol" had been used for resisting sulphuric acid, and he confirmed that it would be worth while trying out this material for the service required.

Referring to the question of a hollow box casting, nickel could never be put forward as a cure for troubles due to gassy metal or to damp sand. Nickel, while exerting a controlling influence on the structure of the metal in a casting, could never be considered a cure for troubles such as that met by Mr. Honeymore.

A vote of thanks was proposed by Mr. Pease, which was seconded by Mr. Russell and carried with acclamation. Dr. Everest suitably replied.

Catalogue Received.

Case Hardening.—The Cassel Cyanide Company, Limited, Oldbury, near Birmingham, has sent us booklets dealing with three phases of case-hardening practice. One is devoted to a furnace specially designed to take care of this process. It is heated by town's gas in such a manner that a reducing, or at least a neutral, atmosphere is prevalent. This pamphlet presents a most exhaustive account of the construction and operation of the furnace.

The second pamphlet is devoted to sodium cyanide, and its position in industry is such that it is the process by which the effectiveness of proprietary compounds is compared. The pamphlet is carefully prepared, and anyone who can read the King's English should have no difficulty in ensuring successful results initially. Whilst normally low-carbon steel, with or without nickel, is used for case hardening, experiments on skin-hardening malleable or grey-iron castings might be productive of some interesting results, as is indicated by the recent nitriding process and its modifications.

The third pamphlet deals with the heat-treatment of steel in molten-salt baths. From personal experience, a word of warning is here desirable. It is essential that the salts be purchased from really reliable firms, as any contamination with sulphates or sulphides can adversely influence the composition of the steels being treated. Actually, a consignment of barium chloride once used by us contained sufficient barium sulphate to ruin several batches of high-class steel tools. The authors of these pamphlets, and this last one in particular, are to be congratulated in the way they have made quite difficult matter read so simply and thus have rendered a great service to those unfamiliar with metallurgical science.

Steel Selling Company in Japan.—According to a report received by last mail from Yokohama, at a meeting of the Iron and Steel Conference, it was decided to organise a company with a capital of 4,000,000 or 5,000,000 yen (£400,000 or £500,000) for the purpose of selling on joint account round, square and flat bars and angles, the normal production of which was put at 300,000 metric tons, uniting all the existing selling unions of such goods.

Institute of British Foundrymen.

ANNUAL MEETING OF WEST YORKSHIRE BRANCH.

The annual meeting of the West Yorkshire Branch of the Institute of British Foundrymen was held on April 25 at the Bradford Technical College, the retiring President, Mr. H. Sayers, in the chair.

The Session Reviewed.

The Hon. Secretary (Mr. S. W. Wise), in his annual report, expressed the view that after carefully reviewing the work of the year, and especially having in mind the state of trade and industry, members had every reason to be optimistic as to the future of the Branch. They had held their own financially and numerically in spite of the continuance of trade influences. They commenced the session with what had rightly been termed, in The Foundry Trade Journal, a clarion call from Yorkshire, by the Branch-President (Mr. Sayers) in a presidential address which had called forth favourable comment from other Branches of the Institute. They had had three interesting and instructive works visits during the year—to Messrs. Blakeborough, of Brighouse, Messrs. Sligsby's, of Keighley, and the engineering department of the Bradford Technical College—a College which he thought they could truly call "our own Technical College" because of the sustained kindness which the Branch had received from its authorities since the early days of the Branch. The past session had put them under a further debt of gratitude to the College by reason of the valuable lecture given them by Dr. Swift, head of the department of mechanical engineering. Amongst other Papers of a very high order during the year, those by Mr. Griffiths (Rochdale), on Belgian moulding sands, and Mr. Flower, on the venting of dry-sand moulds, had provoked lively discussion. Mr. France had spoken on mould and core drying—a subject much appreciated by the members. The fact that the Keighley Association of Engineers invited the Branch to send a member to lecture to them (Mr. Wise himself) was further proof of the useful activities of the Branch. The technical library it had established continued to be much used, and its influence was very noticeable in the discussions.

The forthcoming year was likely to prove a memorable one in the history of the Institute, as the efforts taken by a number of the members in trying to improve the personnel of the industry were likely to be brought to fruition by the launching of the scheme for Craft Certificates for foundry and patternshop apprentices, and the prospect of the City and Guilds Institute co-operating with the Institute of British Foundrymen in an educational scheme of an ambitious character. Two members of the Branch, Mr. A. S. Worcester and Mr. H. Forrest, had been elected on technical committees. The foundry industry in general, and the West Yorkshire Branch in particular, had suffered serious loss by the death of Mr. W. H. Poole, of Keighley, whose place in discussions would not readily be refilled. The balance-sheet showed a slight increase in the credit balance.

Election of Officers.

The following officers were elected for the next year: Branch-President, Mr. A. S. Worcester; Senior Vice-President, Mr. R. D. Welford; Junior Vice-President, Mr. J. J. Watson; hon. secretary and treasurer, Mr. S. W. Wise; representatives to General Council of the Institute, Mr. Worcester and Mr. Forrest, in addition to Mr. Wise (*ex-officio*); auditors, Mr. R. D. Welford and Mr. W. Hird; librarians and registrars, Mr. Forrest and Mr. Stanley Wise; added to the Council, Messrs. J. Butterworth, W. Hird and J. W. Blair.

Mr. A. S. Worcester gave a brief report of the activities of the General Council of the Institute, on which he had served during the year, and particularly of the Glasgow meeting and recent developments generally. The Council, or the Technical Committee, had had meetings at Birmingham, Gloucester, Manchester, Sheffield and Glasgow, so that members might realise that membership of those bodies was no light job. By comparison with some at extreme ends of the country, Mr. Forrest and himself, being about half-way between North and South, were fairly fortunate. Membership of the General Council involved a certain amount of expense in time and money. Among the most important matters to-day, of course, was the new educational scheme for the City and Guilds of London certificates. To his mind, the development now being made by the Institute on the educational side was one of the best and finest things it had ever done. All foundries and all technical colleges in foundry areas would hear more of this scheme shortly, and he hoped foundrymen and apprentices would give the scheme their utmost encouragement and support. Mr. Worcester referred also to the new scheme of a monthly publication, which would give references from the best current technical literature.

The Institute's Activities.

Mr. Tom Makemson, general secretary of the Institute, who came specially from Manchester, addressed the meeting briefly on current activities of the Institute. It was, he said, a matter of great regret to the Presidents of the Institute during the past two years that neither of them had found it possible to pay the anticipated visit to the West Yorkshire Branch. It so happened that the functions of the ten Branches of the Institute—mostly crowded into a winter session—had a tendency to clash. Last year's President, Mr. Wesley Lambert, C.B.E., had to forgo a Yorkshire visit because of a promise to Lancashire; and this year, Mr. F. P. Wilson, J.P., missed visiting the West Yorkshire Branch because, on the only occasion when he was able to make an appointment, he found the roads so snowed up in the North that he was unable to get through.

The West Yorkshire Branch was to be congratulated on the successful session it had had, and particularly on having slightly increased its membership. The good attendances at its meetings, bearing in mind the rather exceptionally-scattered area and the considerable travelling involved, was indicative of the genuine enthusiasm and interest of the members generally in the work of the Branch and of the Institute. Mr. Worcester had made some mention of the developments which the Institute was undertaking at present. Indeed, it almost seemed as though the Institute was turning itself inside out and two or three years' time would be a vastly different organisation. The work of the General Council had lain chiefly in connection with Branch finance, works visits, the annual conference and other activities centring mostly about the Branches. They had come now, however, to a stage when they were carrying out work and movements to the benefit of the industry as a whole, and more and more the General Council would have to get down to some very important matters. The establishment of the Technical Committee was one such important matter. For some years past the Institute had been approached as to the possibility of assisting in drafting specifications and similar advisory work, and it was felt it was high time some definite machinery was established to deal with matters of that kind. The Technical Committee quickly found other matters needing attention, amongst which was the large number of variations of specifications which existed in the foundry institute and the serious need for some determined effort at standardisation. The Committee was hoping to take some action, probably through the help of the British Engineering Standards Association, to reduce as far as possible the number of specifications to which the industry had to work.

Technical Education.

The literature mentioned by Mr. Worcester was another important work now progressing. In a few months' time all members would receive a monthly booklet referring to all the most important technical current literature, both in the technical journals and otherwise. In regard to the establishment of the Craft Certificates, Mr. Makemson said he was glad to see that they in the West Riding Branch had been in touch with the Bradford Technical College authorities with a view to classes there. The certificates in patternmaking and foundry practice, which were to be taken through the City and Guilds of London Institute, would be of a national character and value. An advisory committee in that matter had been set up a year or more ago and had now finally drafted the syllabus and regulations, and every member of the Institute would receive a copy of these. Before next winter opened it was hoped to circulate a copy to every foundry proprietor in the country, and, in the meantime, the technical colleges were being approached with a view to the establishment of foundry classes. It was obvious that it was now up to the Institute and its members to see to it that the necessary students were forthcoming to justify all this work. A good many technical colleges in the past had set up classes, but had found sufficient students were not forthcoming and had had to abandon the classes. The educational people, on the whole, were very willing, but they could not spend public money and effort without some sort of assurance that it would be utilised, and it was the duty of the members of the Institute, collectively and individually, to do their utmost to persuade the young men in the industry in their own areas to join the classes. Such tuition would, of course, make them better men at their jobs, would help them in getting promotion and to be generally cultural. There was no gainsaying the fact that the foundryman of the future who wished to make real progress must gain a wider technical knowledge than was possessed by the previous generation of men in the industry. Good as was the knowledge of the experienced and practical foundrymen of to-day, the men of the future must add to that practical knowledge a knowledge of the technical side, which could only be obtained through such special training as was now to be offered.

Another certificate, of a somewhat higher nature, was to be offered through the help of the Institution of Mechanical Engineers. That Institution, in conjunction with the Board of Education, had agreed to issue a certificate on the lines of that of the Institution of Mechanical Engineers, but somewhat modified to suit the foundry trade. This, of course, would be available only for men who were prepared to go through a longer and somewhat advanced course. They would have to be men who had the foundation of a higher standard of general education than the average man coming into the foundry. It was hardly to be expected that there would be as many going in for this as for the City and Guilds of London certificate, but it was confidently hoped that there would be a sufficient number to justify the special facility offered. Mr. Makemson was very glad to be able to say that although this scheme was only made known to the technical colleges of the country at the beginning of last winter, five such colleges had already had their schemes submitted and approved, and he was particularly glad that evening to be able to say that one of

(*Concluded on page* 360.)

Foundry Selling Practice.

By Eric N. Simons.

(*Continues from page* 345.)

No. 4. OBTAINING MARKET INFORMATION.

Information concerning the market, and where to look for it, constitute one of the main needs of the founder and his selling organisation. As briefly as possible, this section will deal with these points. Information can be classified as (*a*) bibliographical; (*b*) statistical; (*c*) personal.

Bibliographical information is more generalised than the other two kinds, and can be obtained from books, from periodicals, and from pamphlets and trade literature. The books dealing with a particular industry or market are usually obtainable in public libraries, and many invaluable works of importance to the sales manager desirous of getting to know everything there is to know about a market can be borrowed or read in technical or scientific libraries. In this connection it is worth while noting that the association of Special Libraries and Information Bureaux exists primarily for the purpose of correlating and rendering more available all the indispensable information to be found in special libraries. Any reader wishing to know more about the services this Association can render to the seeker after facts should ask the Editor for the address of the Association. Briefly, it can be said here that anyone who wishes to know in what publications, books or periodicals, he can find the data he wants on a particular industry or subject, can get from "Aslib," as the Association is called for brevity's sake, all the help he needs.

The reader will not need to be told how to get hold of Governmental blue books or trade literature (catalogues, pamphlets, etc.) in regard to the markets in which he is interested, and so far as periodicals and trade papers are concerned, his local branch of W. H. Smith & Company's great organisation will rapidly give him the necessary details.

Statistical information is such as gives actual facts and figures that can be utilised in the building up of charts and surveys of the market. It is obtained from Governmental publications, such as reviews of current trade, consular reports, weekly summaries of overseas trade, Census tables and figures, reports of commissions. Much information of a similar character can be obtained from those trade journals that pride themselves on their ability to give information about markets. The Foundry Trade Journal does this sort of thing. I hold strongly to the belief that a trade journal should have accessible in its offices every possible valuable fact and figure concerning, for example, the foundry industry just as the "Iron and Coal Trades Review" should hold data that would make the mouths of sales managers water concerning the iron and coal trades.

Other sources of statistical data are reports of trade associations and their journals; figures and details collected by private organisations and federations; professional statisticians, like my friend, Dudley Walton, who, in London, acts as a professional investigator of sales and market information for quite a number of important manufacturers; and those rare and eccentric bodies, the statistical societies.

One next comes to the personal type of information, which consists principally of the direct questionnaire and the personal interview. Questionnaires are more largely employed in the United States than in this country, and it is as well. No British manufacturer wishes to have his correspondence departments clogged with lists of unanswerable questions from energetic sales managers. If, in the course of ordinary correspondence, the sales manager or founder can introduce a few questions concerning the conditions obtaining at his customer's end, so much the better. Such information, when obtained, should be carefully recorded on the individual sheets that, in the soundly organised sales department, are devoted to each firm. But it should be obtained less cheekily and bluntly than is possible with the set questionnaire. There are, of course, kindly people who will reply in detail to questionnaires, but they are few and far between, and their replies are not always accurate. Many a questionnaire form has been answered waggishly, for the fun of the thing.

Personal interviews are another matter. There is no reason why a sales manager seeking information about the value of a type of casting to his particular market should not go and see in person a few of his most likely customers, and discuss the matter with them. Assuming he belongs to a firm with a good reputation, or is himself a tolerably likeable person, he will generally find people willing and ready to give him all the help they can, so long as he does not presume upon their good-nature. Such interviews are not only a sound and effective method of acquainting the sales manager at first hand with his customers and his market, without his in any way poaching on the district salesman's preserves or weakening the latter's influence, but they also tend to awaken the customer's or potential customer's interest in the product, and give him a personal association with it. He watches his progress because he has himself offered advice or been consulted in regard to it.

But not only the sales manager can acquire data by the personal method. The district representatives are in theory the best guides to the market, and their reports should contain as a regular thing just the type of market information that is necessary to the sales department. But it is not always the best men at reporting facts who are the best at selling, and *vice versa*. After all, a salesman's job is to sell, and while he should, wherever possible, give information that he feels to be helpful, he should not spend time on ferreting out facts that should be devoted to selling goods. It is best for the sales manager not to rely too much upon his salesmen for market information, as a regular thing. But every now and then he may quite rightly ask them or instruct them to call upon a particular firm and ascertain to the best of their ability their use for the product, its value to them, the conditions under which they will use it, and so forth.

Standardised Reagents and Metals for Metallurgical Control.

In addition to the standard analysed samples of steels, irons, ores and non-ferrous alloys which British Chemical Standards has prepared from time to time since 1916, a need has been felt for certain standard reagents and metals of the highest grade of purity—similar to those issued by the U.S. Bureau of Standards—for volumetric analysis, calorimetry and pyrometry.

Material.	Purity. Per cent.	M.P., deg. C.	Calorific value.	Chief uses.
Benzoic acid ..	99.9	—	6.325	Calorimetry and standardisation of volumetric solutions of NaOH, etc.
Sod. oxalate ..	99.94	—	—	Standardisation of N/10, etc., potassium permanganate.
Tin	99.98	232	—	Calibrating pyrometers and volumetric analysis.
Lead	99.98	327	—	Calibrating pyrometers, assaying and volumetric analysis.
Zinc	99.95	419	—	Calibrating pyrometers, volumetric analysis, and As tests.
Aluminium ..	99.82	658	—	Calibrating pyrometers.
Sod. chloride ..	99.96	801	—	Calibrating pyrometers and volumetric analysis.
Copper	99.91	1,083	—	Calibrating pyrometers and volumetric analysis.

The classifying of reagents as "chemically pure" has but little meaning, and gives chemists no precise information as to the extent or nature of the impurities which may be present. The "A.R." classification is a step in the right direction, and indicates many of the limits of impurities which may be expected; but, whilst this is a considerable help, it is felt that for a few special standardising purposes many chemists would like to be able to obtain from a reliable and impartial source supplies of certain high grade reagents and metals with a definite guarantee as to their purity and a definite statement of the amount of the impurities they contain.

British Chemical Standard Headquarters are, therefore, attempting to meet this requirement, and the table below indicates at a glance what substances are now available.

Each sample is issued with a certificate of analysis, together with the calorific value, or exact melting point according to the purpose for which the material is intended, also working details for its use.

As an example, the B.C.S. Benzoic Acid makes an excellent standard, not only for calibrating the Mahler bomb type of calorimeter, but also the sodium peroxide type of calorimeter, such as Roland Wild's. The same reagent may be used to advantage as a primary standard for alkalimetry—a use which is not yet sufficiently appreciated in Great Britain.

The prices of the samples range from 7s. 6d. to 10s. 6d. each; and anyone who is sufficiently interested is advised to send to the headquarters of the movement, 3, Wilson Street, Middlesbrough, for a free descriptive leaflet.

Institute of British Foundrymen.

(*Concluded from page* 359.)

these five was the Technical College at Bradford. This indicated a good deal of courage on the part of the College authorities, and the fact that Bradford College was willing to have a try at the advanced course, which could not be expected to attract a large entry of students, showed how anxious that College was to help the industry—as, indeed, it had been in other ways. He hoped the West Yorkshire Branch would give the students every encouragement to go in for the courses and examinations.

Mr. Makemson proceeded to draw special attention to the new membership badge, and expressed a hope that members generally would justify the adoption of this medium of recognition by purchasing and using the badge. In appealing for general co-operation in the effort to enlarge the membership of the Institute, he said that the time was undoubtedly coming when the question would not be raised by any foundryman as to whether he could afford to be in the Institute, but as to whether any man who expected to have any kind of good prospects in the industry could afford to be out of it.

In proposing thanks to Mr. Makemson for his address, Mr. Sayers said it was for all who had the interests of the industry at heart to try and make it worth while for the young men to attend the classes offered. The resolution was seconded by Mr. Wise and carried.

A mixture of three bushels of sawdust and 10 lbs. of carbonate of soda is excellent for extinguishing petrol or oil fires.

Trade Talk.

The Doncaster Electricity Committee recommends the acceptance of the tender of the Metropolitan-Vickers Electrical Company, Limited, for high-tension switchgear.

The Belfast Electricity Committee has recommended the tender of Messrs. Babcock & Wilcox, Limited, which amounts to £82,146, for the new water-tube boiler required in connection with the development of the harbour power station.

An action in the Chancery Division by Mr. William E. Styles, formerly manager of the motor-cylinder department of Messrs. R. & W. Crosthwaite, Limited, of Thornaby-on-Tees, against that company and its joint managing director, Mr. Cedric Crosthwaite, was settled. The case related to an improved method of casting motor-car cylinders.

We are informed that Ealing Park Foundry, Limited, South Ealing, London, W.5, have taken over the goodwill, patterns, drawings, etc., of the well-known Marcus Allen centrifugal pumps, and have received a large order for these pumps for export. This new business will be run in connection with the foundry, which has been recently equipped with a thoroughly modern plant. Ealing Park Foundry, Limited, has also taken over the agency for the whole of Great Britain, Free State of Ireland and British Dominions, for foundry equipment made by the Société des Etablissements Utard, France.

Messrs. Davidson & Company, Limited, Sirocco Engineering Works, Belfast, have received a contract for mechanical boiler draft and flue-dust collector equipment amounting to over £100,000 from the Newcastle-upon-Tyne Electric Supply Company, Limited. The equipment is required for the new power station at Dunston-on-Tyne. The boiler plant, for which this mechanical-draft installation is intended, comprises 12 units, each capable of generating 156,000 lbs. of steam per hr. Eight of the boilers will be fired by mechanical stokers, and the remaining four will be fired with pulverised fuel. The boilers will be arranged in three groups of four boilers, each group supplying steam to a turbo-alternator set of 50,000-kw. capacity taking superheated steam at 625 lbs. per sq. in. and at a temperature of 840 deg. F. The mechanical-draft plant will comprise 48 electrically-driven fans, 24 for forced draft and 24 for induced draft. Altogether 72 flue-dust collectors are being supplied in groups of six collectors per boiler unit.

Personal.

Commander C. W. Craven, R.N., has been appointed managing director of all works and shipyards of Messrs. Vickers-Armstrongs, Limited.

A presentation of a set of silver fish-eaters was made to Mr. Ernest Holt, manager of Messrs. Edward Kempster & Sons, Limited, brass founders, Bury, Lancashire, on the occasion of his recent marriage.

Mr. S. C. Giggings, assistant secretary of the Institute of Metals, states that his family name has been changed to that of another branch of the family—Guillan, and that in future he will on all occasions use that name.

Mr. H. Steel (United Steel Companies, Limited) and Mr. A. Ahier (Lord Leconfield's mines) have been appointed directors of the Cumberland Iron Ore Proprietors' Indemnity Association, Limited, in succession to the late Mr. J. W. Pattinson and the late Mr. R. E. Highton.

Wills.

Anderson, J., of Musselburgh, retired ironfounder	£7,206
Owen, H. J., senior partner in Norton, Owen & Company, metal and tinplate merchants, London, E.C.2.	£57,000
Pilling, H., a director of Messrs. Galloways, Limited, ironfounders and boiler manufacturers, Knott Mill Ironworks, Knott Mill, Manchester...	£20,714

Contracts Open.

Cheltenham.—1¼ miles of 4-in. cast-iron water main, for the Town Council. The Borough Engineer, Municipal Offices, Cheltenham. (Fee £3 3s., returnable.)

Swansea.—Iron and steel stores, for the Amalgamated Anthracite Collieries, Limited. The Controller of Stores, Amalgamated Anthracite Collieries, Limited, Eagle Chambers, Swansea.

El Arish, Egypt, June 15.—Pumping plant, etc., for the Ministry of Public Works, Cairo. The Department of Overseas Trade. (Reference G.X. 10,370.)

Reports and Dividends.

Siemens Bros. & Company, Limited.—Final dividend of 5 per cent., making 7½ per cent. for 1930.

Tweedales & Smalley (1920), Limited.—Final dividend of 5 per cent., making 7½ per cent. for the year.

Union Steel Corporation (of South Africa), Limited.—Trading profit, £21,405; general expenditure, debenture service and other charges, £38,305; net loss, £16,869.

Staffordshire Iron and Steel Institute.

Annual Meeting.

The annual meeting of the Staffordshire Iron and Steel Institute was held at Dudley on April 28, Mr. T. Hoskinson (President) in the chair.

Mr. S. J. Astbury (Secretary), in his annual report, said that the past session was the most successful the Institute had had for many years, although it coincided with a period of industrial depression without equal in the iron, steel and engineering industries. Their membership had increased, their revenue was higher, their meetings, without exception, had been much better attended, and a much greater percentage of their members were taking a keen and active interest in the affairs of the Institute. The Council had decided to continue with the co-ordination with the Birmingham Metallurgical Society and the local section of the Institute of Metals, and by that means their members were given a very wide choice of Papers and lecturers. Since January, 10 new members had been elected, so that the total now stood at 215.

Mr. Hoskinson, describing the reports as "very satisfactory," said it was evidence of the work which the Council had done in recent years to improve the affairs of the Institute. A few years ago they all felt that they were getting into rather low water, but that by goodwill and hard work they could pull the affairs of the Institute round and place them on a more satisfactory footing. He thought they would agree that the reports were evidence of the fact that their endeavours were bearing fruit.

In proposing that Mr. Robert Bethell should be elected President for the ensuing year, Mr. Hoskinson said he was quite sure Mr. Bethell would be a very hard-working President and that he would carry on the traditions of the Institute with honour both to it, and to himself.

The resolution was carried unanimously.

Aluminium in "The Bluebird."

It is of interest to note that the 1,300-h.p. car in which Sir Malcolm Campbell recently raised the land-speed record to over 246 m.p.h. contains a considerable amount of aluminium. In the first place, the supercharged Napier "Lion" aero-engine, which has a capacity of nearly 24,000 c.c. and weighs only ¾ lb. per b.h.p., includes pistons of forged "Y" alloy, crankcase of 2 L.5, carburettor body and camshaft covers of RR 50, and impeller forging of RR 56, while the rear cover is also of aluminium alloy. Other light metal parts are the rear axle centre casing, brake shoes (of Wilmil), steering gear columns and castings, and wheel discs, while over 600 sq. ft. of aluminium panelling were used for the body and fairings; and this is the car described in the American Press as *all-steel*!

Cupola High-Test and Alloy Irons in a Machine-Tool and Grey-Iron Jobbing Foundry.

A Paper by Mr. L. M. Sherwin and Mr. T. F. Kiley, presented at the Chicago Convention of the American Foundrymen's Association, deals with the cupola practice, mixture and materials used in manufacturing a low-carbon (2.75-3.00 per cent.) iron, commonly referred to as high-test cast iron and used on certain classes of work with success by the authors' firm. The methods of control, typical analyses of resulting product and microstructures are discussed and comparisons made between machining, strengths and other physical characteristics of this and other iron mixtures regularly used. The production of sound castings of difficult design is stressed more than high strength, although the latter generally follows with such irons. Problems involved in pouring, feeding and gating are more difficult than those encountered with usual grades of iron. Special dry-sand mixtures apparently are necessary to obtain a sound, smooth-surface casting on medium and heavy work. Castings illustrated and poured successfully with high-test iron include those which have been found very difficult to get sound from mixtures containing up to 30 per cent. steel, even with low-silicon content, without resorting to chills; castings of such design as to favour a draw between thin and adjoining heavy sections; heavy-sectioned castings requiring absolute soundness when machined deeply; castings used in hydraulic work or where subject to high pressures; castings where high strength or exceptional wearing qualities are demanded. The cost of castings made from high-test iron is more than with regular grades of iron, due in most cases to dry-sand moulding, increased supervision, more coke, larger foundry returns and the use of best moulders. The effect of molybdenum on low-carbon iron and a regular 20 per cent. steel mixture is described, also nickel as an aid in machining when using a mixture of iron suitable for castings of difficult design or in securing castings with better wearing qualities, and also chromium-treated irons for castings subject to heat or great wear. The decision whether to use high-test or alloy iron, rather than chill and green sand, is decided in a preliminary investigation, the ultimate cost being the deciding factor where either method will result in a satisfactory casting. The authors consider high-test and alloy irons a valuable aid in meeting special needs of the customer and in the production of quality castings where design is difficult.

Aluminium Alloys used in New Chain Hoist.

The "Al-Lite" hoist is described as the first chain hoist to be made of aluminium alloys, and is being placed on the market by the Chisholm-Moore Hoist Corporation, Tonawanda, N.Y. One man can lift and carry the new hoist, which is one-third lighter than similar equipment made of heavier metals. Strength as well as lightness is obtained, the hoists being tested under a 50 per cent. overload. The planetary reduction gears of the "Al-Lite" hoist are enclosed in a dustproof housing. "Inswell" chain is supplied. Other features include ball bearings, Alemite lubrication, and an adjustable brake which is secure and positive in action. The hoist is finished in bright aluminium and will not corrode.—"The Iron Age."

Stainless-steel nuts and bolts should have a slightly easier fit than those of mild steel, they should be accurate and well finished. This prevents any possibility of seizure.

Hard steel can be tinned by first removing all scale and then placing for a few minutes in a bath composed of 1 part hydrochloric acid and 20 parts water. The steel is then immersed in a bath of solder.

Iron and Steel Markets.

Pig-Iron.

MIDDLESBROUGH.—The market in Cleveland is quite listless and buyers are completely apathetic. There is a general lack of confidence. Influenced, no doubt, by the conviction that there will soon be a reduction in prices, consumers are covering their limited requirements for only a week or two ahead. So far, however, the ironmasters seem determined to make no price concessions, on the grounds that to increase their output of iron would merely be to increase their losses. Concessions are still offered to Scottish consumers, but only a very limited trade is attracted, owing to the much lower prices at which Continental and other iron is still obtainable in that area. Prices to other destinations remain unaltered as follow:—No. 1 Cleveland foundry iron, 61s. per ton; No. 3 Cleveland G.M.B., 58s. 6d.; No. 4 foundry iron, 57s. 6d.; No. 4 forge iron, 57s. per ton, f.o.b. or f.o.t.

The hematite market is still moderately satisfactory. After being idle for about ten months, Messrs. Gjers, Mills & Company have re-started two hematite furnaces at the Ayresome Ironworks, Middlesbrough. It is understood that the firm have secured a special contract which will ensure continuity of operations for 10 or 12 weeks, by which time it is hoped that the industrial situation will have shown such improvement as may justify the continuance of operations at these works. There has been a further reduction in hematite prices this week, the current market quotation for East Coast mixed numbers being now no more than 65s. per ton, and it is understood that larger contracts could be placed at still lower figures. There are, however, some makers who take the view that prices are likely to advance, and they are not prepared to sell at the low figures now current. There is still no alteration in the quotation of 68s. at works for Bessemer mixed numbers on the North-West Coast.

LANCASHIRE.—There is still no sign of the improvement which was expected to take place in the foundry trade of this district. The general impression on the Manchester Exchange is that in the aggregate more short time is being worked in Lancashire than was the case at the beginning of the year. Makers complain of the insignificance, both in numbers and volume, of the orders which are now being placed. The prices of Midland iron have been reduced by 2s. 6d. per ton. For delivery to consumers in the Manchester zone, Derbyshire and Staffordshire descriptions are now quoted at 67s. per ton, with North-East Coast iron also at 67s. The price of Northamptonshire foundry is 65s. 6d., Derbyshire forge 62s., Scottish foundry brands 88s. 6d., and West Coast hematite iron 82s. 6d.

MIDLANDS.—The volume of business passing is small and confined to small quantities for immediate needs. Consumers have for some time past been expressing their dissatisfaction with current values, and now that prices have been reduced by 5s. per ton, trade may be stimulated. For delivery to Birmingham and Black Country stations the furnaces now quote 62s. 6d. for Northants No. 3 and 66s. for Derbyshire, North Staffordshire and Lincolnshire No. 3.

SCOTLAND.—This market leaves much to be desired. The founders complain of lack of orders and are mostly working short time. The price of Scottish foundry iron is 73s. 6d. per ton, f.o.t. furnaces, with a minimum of 2s. 6d. per ton extra for No. 1. The price of Continental No. 3 is 52s., f.o.t. Grangemouth, and Middlesbrough No. 3 is at 59s. 6d.

Finished Iron.

The South Staffordshire market is irregular, and business generally is unsatisfactory. The makers of marked bars, although in a rather better position than producers of the cheaper grades, are anything but well placed and are anxious for more business. No orders involving any substantial tonnage are given. Marked bars are at £12 at works. Prices of crown bars vary from £9 5s. to £10. A good crown iron could be obtained at £9 15s. Nut and bolt iron is at from £8 12s. 6d. to £8 15s. Bolt bars are in very poor demand, as not only are the consuming interests badly situated for work, many of them operating at less than half their capacity, but foreign iron is still very competitive. For the common trade the bulk of business is going to the Belgian and French works, which, in spite of labour difficulties, are still getting supplies through. Continental quotations are at from £4 15s. to £4 17s. 6d.

Steel.

The demand for finished steel sections and plates is poor, and all the works badly need orders. The shipbuilding and heavy engineering industries are very short of work, and railway and other interests seem to have covered their requirements for the time being. The market for small steel bars is weak. British makers are maintaining their prices for semi-finished steel, although lower figures would no doubt be taken for substantial tonnages. Prices of Continental semis are still declining. The current rate for sheet bars f.o.b. Antwerp is £3 6s., and some sales have been reported at slightly less than this figure. The large buyers of Continental semis have recently again come into the market, but other consumers are holding back in the hope of still lower prices.

Scrap.

In the Cleveland market values of certain descriptions of iron and steel scrap have again given way. Ordinary-quality cast-iron scrap is at 45s., with good machinery quality at 46s. 6d. It is almost impossible to obtain new business in the Midlands, and, with the failure of many firms to take delivery against existing contracts, prices have an even weaker tendency. Good heavy machinery cast-iron scrap in cupola sizes is offered at 50s. to 52s. 6d., with light cast iron at 37s. 6d. Business in Scotland is more or less at a standstill. Only small lots change hands, and the tonnage being delivered even against old contracts is restricted. First-class machinery metal, in pieces not exceeding 1 cwt., is still at 50s., while ordinary cast-iron scrap to the same specification is at 46s. 6d. to 47s. 6d. The above prices are all delivered consumers' works.

Metals.

Copper.—With the exception of the further reduction in the stocks of blister copper, the U.S. copper statistics are most unsatisfactory, and, judging by the reports as to industrial conditions in America, there seems little hope of any material improvement in the rate of copper consumption.

Closing quotations :—

Cash.—Thursday, £39 to £39 2s. 6d.; Friday, £39 7s. 6d. to £39 10s.; Monday, £39 3s. 9d. to £39 5s.; Tuesday, £38 17s. 6d. to £38 18s. 9d.; Wednesday, £38 13s. 9d. to £38 16s. 3d.

Three Months.—Thursday, £39 12s. 6d. to £39 13s. 9d.; Friday, £40 1s. 3d. to £40 2s. 6d.; Monday, £39 16s. 3d. to £39 17s. 6d.; Tuesday, £39 8s. 9d. to £39 10s.; Wednesday, £39 6s. 3d. to £39 7s. 6d.

Tin.—During the past week more buoyant atmosphere developed in the tin market. This change of sentiment, of course, was due to the decision of the International Tin Committee at its meeting at The Hague to recommend to the Governments identified with the quota scheme a further curtailment of output equal to 20,000 tons a year (15.9 per cent. of the present quotas). The market was somewhat surprised by this rather drastic move. Oversold operators were eager to cover in the face of new general buying and prices rose rapidly, although there has since been a reaction which has exhausted the whole of the gain. It is expected that the additional cut will be approved by the Governments concerned and will be put into force on June 1. On this new basis the growth of stocks, which have been accumulating for a long time past, should be arrested by the reduced shipments. Therefore, by the end of the year it is hoped that the statistical position will be much better, although it is difficult to forecast the development of consumption during that period. In the first annual report of the Tin Producers' Association, submitted to members yesterday (Wednesday), it was stated that the scheme of voluntary regulation of tin output, which was adopted by the members of the Association in November, 1929, had achieved a considerable measure of success, but, owing to the steady decline in tin consumption during 1930, the voluntary measures proved to be inadequate. It became apparent that, to be effective, the scheme must cover all producers in all the countries concerned. The report stressed the importance of research to widen the existing markets for tin, to create new consuming industries and to examine competitive metals.

Official closing prices :—

Cash.—Thursday, £105 to £105 2s. 6d.; Friday, £105 7s. 6d. to £105 10s.; Monday, £109 12s. 6d. to £109 15s.; Tuesday, £106 17s. 6d. to £107; Wednesday, £105 to £105 2s. 6d.

Three Months. — Thursday, £106 5s. to £106 7s. 6d.; Friday, £106 12s. 6d. to £106 15s.; Monday, £110 17s. 6d. to £111; Tuesday, £108 5s. to £108 7s. 6d.; Wednesday, £106 7s. 6d. to £106 10s.

Spelter.—There has been a slight revival in the demand from consumers in this country. The orders placed, however, have not been sufficient to stimulate values or give any real indication of a definite improvement in consumption.

Daily fluctuations :—

Ordinary. — Thursday, £10 6s. 3d.; Friday, £10 16s. 3d.; Monday, £10 15s.; Tuesday, £10 10s.; Wednesday, £10 7s. 6d.

Lead.—The position is rather uncertain, and the market seems to be awaiting fresh developments. Supplies are still considerably in excess of the consumers' demand.

The week's prices have been :—

Soft Foreign (Prompt).—Thursday, £11 7s. 6d.; Friday, £11 10s.; Monday, £11 12s. 6d.; Tuesday, £11 10s.; Wednesday, £11 11s. 3d.

Company Meeting.

Babcock & Wilcox, Limited.—Sir John Dewrance, presiding at the annual meeting of Messrs. Babcock & Wilcox, Limited, said that the company was fortunate that its order book was such a satisfactory one. The fact that they had a large volume of orders in hand and at the same time were able to continue trading to a greater extent than might have been anticipated in the then prevailing circumstances, had resulted in the statement placed before the shareholders, of which he felt justly proud. In view of the strong position of the company the board had felt justified in proposing a final dividend of 7 per cent., free of tax.

CAST IRON FLANGED PIPES
2 in.–12 in. & CONNECTIONS. to 24 in. dia.
WE HAVE FIFTY-TWO YEARS OF ACCUMULATED EXPERIENCE AND METAL PATTERNS.
JAMES & RONALD RITCHIE, LTD.,
Telephone: 3852 (2 Lines). MIDDLESBROUGH. Telegrams: "Ritchie, Middlesbrough."

Special CARBON BLACKING

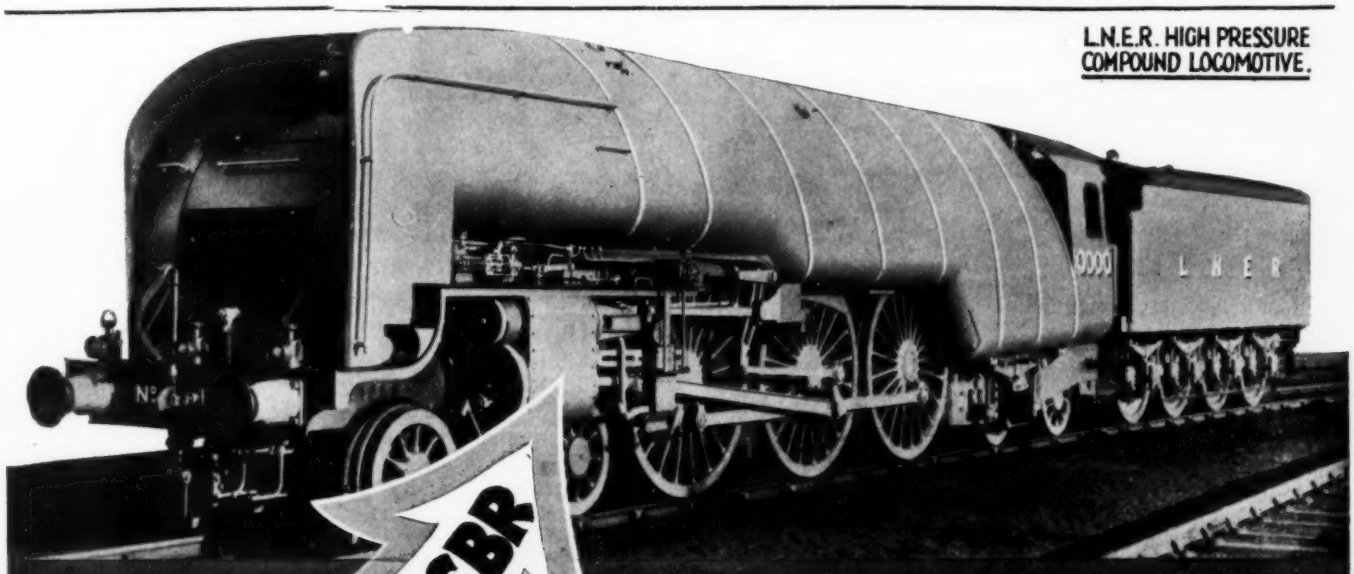
PLUMBAGO
CORE GUM
WHITE DUST
COAL DUST
REQUISITES

67 MADE BY A FIRM WITH YEARS EXPERIENCE.

JAS. DURRANS & SONS LIMITED.
PHŒNIX WORKS, PENISTONE, NR SHEFFIELD.

Also—
GANISTER, LOAM AND SAND MILLS.
STUDS, CHAPLETS, BRUSHES, CORE ROPES, BUCKETS, SPADES, ETC. LADLES, FIRE BRICKS, STONE FLUX, CASTING CLEANERS, PIPE NAILS, SPRIGS, WIRE BRUSHES, BELLOWS.

L.N.E.R. HIGH PRESSURE COMPOUND LOCOMOTIVE.



WARNER CBR

WARNER CBR
CYLINDER PIG IRON.
SPECIFIED BY THE L N E R FOR THE CAST IRON LOW PRESSURE CYLINDERS OF THE ABOVE LOCOMOTIVE. THEIR COMPLETE CONFIDENCE IS THE RESULT OF LONG EXPERIENCE WITH WARNER CBR IN ALL THEIR LOCOMOTIVE CYLINDERS

WARNER & CO. LTD., CARGO FLEET, MIDDLESBROUGH ON TEES.
TELEPHONE — MIDDLESBROUGH 4265 TELEGRAMS — REFINERY, MIDDLESBROUGH

WEEKLY PRICE CURRENT.

COPPER.

	£ s. d.
Standard cash	38 3 9
Three months	39 6 3
Electrolytic	41 15 0
Tough	39 15 0
Best selected	40 0 0
Sheets	73 0 0
India	52 10 0
Wire bars	42 17 6
Do., June	42 17 6
Do., July	42 17 6
Ingot bars	42 17 6
H.C. wire rods	45 0 0
Off. av. cash, April	42 14 8¼
Do., 3 mths., April	43 7 10½
Do., Sttlmnt., April	42 14 9
Do., Electro, April	45 17 0
Do., B.S., April	44 12 6
Do., wire bars, April	46 6 0
Solid drawn tubes	10½d.
Brazed tubes	10¼d.
Wire	6¼d.

BRASS.

Solid drawn tubes	9½d.
Brazed tubes	11½d.
Rods, drawn	8¾d.
Rods, extd. or rlld.	5d.
Sheets to 10 w.g.	8d.
Wire	7¾d.
Rolled metal	7½d.
Yellow metal rods	5d.
Do. 4 × 4 Squares	5½d.
Do. 4 × 3 Sheets	5¼d.

TIN.

	£ s. d.
Standard cash	105 0 0
Three months	106 7 6
English	106 0 0
Bars	108 0 0
Straits	107 0 0
Australian	106 2 6
Eastern	108 2 6
Banca	108 2 6
Off. av. cash, April	112 16 9
Do., 3 mths., April	114 4 9
Do., Sttlmt., April	112 16 9

SPELTER.

	£ s. d.
Ordinary	10 7 6
Remelted	9 12 6
Hard	7 15 0
Electro 99.9	12 12 6
English	10 17 6
India	9 15 0
Zinc dust	19 0 0
Zinc ashes	2 10 0
Off. aver., April	11 11 10¾
Aver. spot, April	11 7 0¾

LEAD.

	£ s. d.
Soft foreign ppt.	11 11 3
English	13 0 0
Off. average, April	12 9 9¾
Average spot, April	12 7 6

ZINC SHEETS, &c.

	£ s. d.
Zinc sheets, English	20 0 0
Do., V.M. ex-whf.	19 0 0
Rods	22 10 0
Boiler plates	13 10 0
Battery plates	15 0 0

ANTIMONY.

	£ s. d.
Special brand, Eng.	36 0 0
Chinese	23 15 0
Crude	22 0 0

QUICKSILVER.

	£ s. d.
Quicksilver	22 7 6

FERRO-ALLOYS AND STEEL-MAKING METALS.

Ferro-silicon—	
25%	£7 10 0
45/50%	£10 10 0
75%	£15 0 0
Ferro-vanadium—	
35/50%	12/8 lb. Va.
Ferro-molybdenum—	
70/75% c. free	4/2 lb. Mo.
Ferro-titanium—	
23/25% carbon-free	9½d. lb.
Ferro-phosphorus, 20/25%	£15 10 0
Ferro-tungsten—	
80/85%	1/8½ lb.
Tungsten metal powder—	
98/99%	1/11½ lb.
Ferro-chrome—	
2/4% car.	£29 0 0
4/6% car.	£21 5 0
6/8% car.	£20 10 0
8/10% car.	£20 0 0
Ferro-chrome—	
Max. 2% car.	£29 15 0
Max. 1% car.	£34 2 6
Max. 0.70% car.	£36 0 0
70% carbon-free	9¾d. lb.
Nickel—99% £170 0 0 to £175 0 0	
Ferro-cobalt	9/- lb.
Aluminium 98/99%	£85 0 0
Metallic chromium—	
96/98%	2/7 lb.
Ferro-manganese (net)—	
76/80% loose £10 15 0 to £11 5 0	
76/80% packed £11 15 0 to £12 5 0	
76/80% export (nom.) £ 9 0 0	
Metallic manganese—	
94/96% carbonless	1/3 lb.

Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

Finished bars, 14% tungsten	£0 2 0
Finished bars, 18% tungsten	£0 2 9

Per lb. net, d/d buyers' works.

Extras—	
Rounds and squares, 3 in. and over	4d. lb.
Rounds and squares, under ½ in. to ¼ in.	3d. lb.
Do., under ¼ in. to $\frac{3}{16}$ in.	1/- lb.
Flats, ½ in. × ¼ in. to under 1 in. × ⅜ in.	3d. lb.
Do., under ½ in. × ¼ in.	1/- lb.
Bevels of approved sizes and sections	6d. lb.

Bars cut to length, 10% extra.

SCRAP.

	£ s. d.	£ s. d.
South Wales		
Heavy steel	2 5 0	to 2 6 6
Bundled steel and shrngs.	1 17 6	to 2 2 6
Mixed iron and steel	1 17 6	to 1 19 0
Heavy cast iron	2 8 6	
Good machinery for foundries	2 12 6	
Cleveland—		
Heavy steel	2 2 6	
Steel turnings	1 8 6	
Cast-iron borings	1 3 6	
Heavy forge	2 14 0	
W.I. piling scrap	2 10 0	
Cast-iron scrap	2 5 0	to 2 6 6
Midlands—		
Light cast-iron scrap	1 17 6	
Heavy wrought	2 12 6	
Steel turnings	—	
Scotland—		
Heavy steel	2 0 0	
Ordinary cast iron	2 6 6	
Engineers' turnings	1 8 0	
Cast-iron borings	1 10 6	
Wrought-iron piling	2 10 0	
Heavy machinery	2 10 0	

London—Merchants' buying prices delivered yard.

Copper (clean)	30 0 0
Brass	21 0 0
Lead (less usual draft)	9 5 0
Tea lead	6 5 0
Zinc	4 10 0
New aluminium cuttings	46 0 0
Braziery copper	27 0 0
Gunmetal	30 0 0
Hollow pewter	70 0 0
Shaped black pewter	45 0 0

PIG-IRON.

(f.o.t. unless otherwise stated.)

N.E. Coast—	
Foundry No. 1	61/-
Foundry No. 3	58/6
Foundry No. 4	57/6
Forge No. 4	57/-
Hematite No. 1	65/6
Hematite M/Nos.	65/-
N.W. Coast—	
Hem. M/Nos. d/d Glas.	73/6
,, d/d Birm.	86/6
Malleable iron d/d Birm.	117/6
Midlands—	
Staffs common*	—
,, No. 4 forge*	61/-
,, No. 3 fdry.*	66/-
Shrops basic	—
,, Cold blast, ord.	—
,, ,, roll iron	—
Northants forge*	57/6
,, fdry. No. 3*	62/6
,, fdry. No. 1*	65/6
Derbyshire forge*	61/-
,, fdry. No. 3*	66/-
,, fdry. No. 1*	69/-
,, basic*	—

*d/d Black Country dist.

Scotland—	
Foundry No. 1	76/-
,, No. 3	73/6
Hem. M/Nos. d/d	72/-
Sheffield (d/d district)—	
Derby forge	58/6
,, fdry. No. 3	63/6
Lincs forge	—
,, fdry. No. 3	63/6
E.C. hematite	81/6
W.C. hematite	84/6
Lancashire (d/d eq. Man.)—	
Derby forge	62/-
,, fdry. No. 3	67/-
Staffs fdry. No. 3	67/-
Northants fdry. No. 3	65/6
Cleveland fdry. No. 3	67/-
Dalzell, No. 3 (special)	105/- to 107/6
Summerlee, No. 3	88/6
Glengarnock, No. 3	—
Eglinton, No. 3	88/6
Gartsherrie, No. 3	88/6
Monkland, No. 3	88/6
Shotts, No. 3	88/6

FINISHED IRON AND STEEL.

Usual District deliveries for iron; delivered consumers' station for steel.

Iron—	£ s. d.	£ s. d.
Bars (cr.)	9 15 0	to 10 10 0
Nut and bolt iron	8 12 6	to 8 15 0
Hoops	10 10 0	to 12 0 0
Marked bars (Staffs) f.o.t.	12 0 0	
Gas strip	10 10 0	to 12 0 0
Bolts and nuts, ¾ in. × 4 in.	14 5 0	
Steel—		
Plates, ship, etc.	8 15 0	to 8 17 6
Boiler plts.	9 0 0	to 9 15 0
Chequer plts.	10 7 6	
Angles	8 7 6	
Tees	9 7 6	
Joists	8 15 0	
Rounds and squares, 3 in. to 5½ in.	9 7 6	
Rounds under 3 in. to ¾ in. (Untested)	7 2 6	to 7 10 0
Flats—8 in. wide and over	8 12 6	
,, under 8 in. and over 5 in.	8 17 6	
Rails, heavy	8 5 0	to 8 10 0
Fishplates	12 0 0	
Hoops (Staffs)	9 5 0	to 9 10 0
Black sheets, 24g.	8 10 0	to 9 10 0
Galv. cor. shts. 24g.	11 0 0	
Galv. flat sheets	11 10 0	
Galv. fencing wire, 8g. plain	12 0 0	
Billets, soft	5 2 6 & up.	
Billets, hard	6 12 6 & up.	
Sheet bars	5 0 0	to 5 5 0
Tin bars	4 15 0	to 5 5 0

PHOSPHOR BRONZE.

	Per lb. basis.
Strip	11¼d.
Sheet to 10 w.g.	11⅜d.
Wire	1/0⅛
Rods	11⅜d.
Tubes	1/0⅜
Castings	11¾d.

Delivery 3 cwt. free.
10% phos. cop. £30 above B.S.
15% phos. cop. £35 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. Clifford & Son, Limited.

NICKEL SILVER, &c.

	Per lb.
Ingots for raising	7d. to 1/1
Rolled—	
To 9 in. wide	1/1 to 1/7
To 12 in. wide	1/1¼ to 1/7¼
To 15 in. wide	1/1½ to 1/7½
To 18 in. wide	1/2 to 1/8
To 21 in. wide	1/2½ to 1/8½
To 25 in. wide	1/3 to 1/9
Ingots for spoons and forks	7d. to 1/3½
Ingots rolled to spoon size	10d. to 1/6½
Wire round—	
3/- to 10 g.	1/4½ to 1/11½

with extras according to gauge.
Special 5ths quality turning rods in straight lengths, 1/3½ upwards.

AMERICAN IRON AND STEEL.

At Pittsburgh unless otherwise stated.

	Dols.
No. 2 foundry, Phila.	17.26
No. 2 foundry, Valley	17.00
No. 2 foundry, Birm.	12.00
Basic	18.26
Bessemer	18.76
Malleable	18.76
Grey forge	18.26
Ferro-mang. 80%	80.00
O.-h. rails, h'y, at mill	43.00
Billets	30.00
Sheet bars	30.00
Wire rods	35.00
	Cents.
Iron bars, Phila.	2.09
Steel bars	1.65
Tank plates	1.65
Beams, etc.	1.65
Skelp, grooved steel	1.65
Skelp, sheared steel	1.65
Steel hoops	1.85
Sheets, black, No. 24	2.15
Sheets, galv., No. 24	2.80
Sheets, blue an'l'd, No. 13	2.00
Wire nails	1.90
Plain wire	2.20
Barbed wire, galv.	2.55
Tinplates, 100-lb. box	$5.00

COKE (at ovens).

Welsh foundry	22/6 to 25/-
,, furnace	15/- to 16-
Durham and Northumberland—	
,, foundry	13/6 to 14/-
,, furnace	13/6
Midlands, foundry	—
,, furnace	—

TINPLATES.

f.o.b. Bristol Channel ports.

I.C. cokes	20×14 box	14/9 to 15/-
,,	28×20 ,,	29/6 to 30/-
,,	20×10 ,,	21/10½
,,	18¾×14 ,,	15/10½
C.W.	20×14 ,,	14/3
,,	28×20 ,,	28/3
,,	20×10 ,,	21/-
,,	18¾×14 ,,	14/9
Terneplates	28×20	31/- per box basis f.o.b.

SWEDISH CHARCOAL IRON & STEEL.

Pig-iron	£6 0 0 to £7 10 0
Bars, hammered, basis	£17 10 0 to £18 10 0
Bars and nail-rods, rolled, basis	£15 17 6 to £16 15 0
Blooms	£10 0 0 to £12 0 0
Keg steel	£32 0 0 to £33 0 0
Faggot steel	£20 0 0 to £24 0 0
Bars and rods dead soft, st'l	£11 0 0 to £14 0 0

All per English ton, f.o.b. Gothenburg.

TUBES AND FITTINGS.
Current Discounts.

	Tubes.	*Fittings.*
Gas	62½%	57½%
Water ..	58½%	52½%
Steam ..	55%	47½%

W.I. 12½% extra.

DAILY FLUCTUATIONS.

Standard Copper (cash).

		£	s.	d.		
May	14 ..	39	0	0	inc.	1/3
,,	15 ..	39	7	6	,,	7/6
,,	18 ..	39	3	9	dec.	3/9
,,	19 ..	38	17	6	,,	6/3
,,	20 ..	38	13	9	,,	3/9

Electrolytic Copper.

		£	s.	d.		
May	14 ..	43	5	0	inc.	25/-
,,	15 ..	43	5	0	No change	
,,	18 ..	42	0	0	dec.	25/-
,,	19 ..	42	0	0	No change	
,,	20 ..	41	15	0	dec.	5/-

Standard Tin (cash).

		£	s.	d.		
May	14 ..	105	0	0	inc.	10/-
,,	15 ..	105	7	6	,,	7/6
,,	18 ..	109	12	6	,,	85/-
,,	19 ..	106	17	6	dec.	55/-
,,	20 ..	105	0	0	,,	37/6

Tin (English ingots).

		£	s.	d.		
May	14 ..	106	0	0	inc.	10/-
,,	15 ..	106	10	0	,,	10/-
,,	18 ..	110	15	0	,,	85/-
,,	19 ..	108	0	0	dec.	55/-
,,	20 ..	106	0	0	,,	40/-

Zinc Sheets (English).

		£	s.	d.		
May	14 ..	20	0	0	No	change
,,	15 ..	20	0	0	,,	,,
,,	18 ..	20	0	0	,,	,,
,,	19 ..	20	0	0	,,	,,
,,	20 ..	20	0	0	,,	,,

Spelter (ordinary).

		£	s.	d.		
May	14 ..	10	6	3	inc.	1/3
,,	15 ..	10	16	3	,,	10/-
,,	18 ..	10	15	0	dec.	1/3
,,	19 ..	10	10	0	,,	5/-
,,	20 ..	10	7	6	,,	2/6

Lead (English).

		£	s.	d.		
May	14 ..	12	15	0	No change	
,,	15 ..	12	15	0	,,	,,
,,	18 ..	13	0	0	inc.	5/-
,,	19 ..	13	0	0	No change	
,,	20 ..	13	0	0	,,	,,

Imports and Exports of Iron Castings in April and the four months 1931, compared with April and the four months 1930.

	April, 1930.	April, 1931.	Four months, 1930.	Four months, 1931.	April, 1930.	April, 1931.	Four months, 1930.	Four months, 1931.
Imports.	Tons.	Tons.	Tons.	Tons.	£	£	£	£
Pipes and Fittings, Cast	697	987	8,708	4,119	8,916	14,644	104,487	54,063
Castings, in the Rough, Iron	145	123	862	661	2,756	2,761	18,291	13,321
,, ,, ,, Steel	1,202	518	5,787	2,264	26,567	10,647	133,811	49,575
Hollow-ware, Cast, not Enamelled	2	1	9	17	221	70	1,083	1,209
,, ,, Enamelled	2	—	7	33	152	47	481	1,445
Exports.								
BUILDERS' CASTINGS—								
To Argentine Republic	133	69	791	358	6,228	2,555	32,311	15,464
,, British South Africa	118	157	764	562	4,692	6,306	30,309	22,740
,, ,, India	110	87	588	479	3,941	3,229	20,920	16,406
,, Australia	42	13	200	52	1,925	741	11,747	2,359
,, New Zealand	82	44	398	188	4,950	2,667	23,657	11,985
Total (including other countries)	1,314	973	6,164	4,310	58,766	42,861	273,195	196,435
PIPES AND FITTINGS—CAST—								
To Argentine Republic	1,546	649	5,218	2,718	13,569	6,129	49,288	25,967
,, British South Africa	571	712	3,687	3,574	6,682	8,209	39,460	42,006
,, ,, India	256	231	1,423	653	3,028	3,809	20,942	12,397
,, Straits Settlements and Malay States	527	190	2,220	741	4,952	2,732	21,551	9,551
,, Ceylon	54	46	289	92	918	910	3,822	1,545
,, Australia	87	—	459	82	1,393	18	7,754	1,585
Total (including other countries)	11,619	6,123	44,230	24,580	125,612	69,967	483,036	283,389
HOLLOW-WARE—								
Cast, not Enamelled, and Cast, Tinned	272	162	1,499	820	9,641	6,281	48,253	28,072
,, Enamelled	51	35	245	186	4,746	3,710	21,568	19,023
CASTINGS, in the rough—								
Iron	100	141	1,046	548	3,762	3,734	26,176	18,916
Steel	92	144	796	631	3,846	4,107	29,066	20,636

WILLIAM JACKS & COMPANY,
WINCHESTER HOUSE, OLD BROAD ST., LONDON, E.C.2.

18, BENNETTS HILL, BIRMINGHAM.
13, RUMFORD STREET, LIVERPOOL.

PIG IRON

REGISTERED TRADE MARK
LUMPE

All grades FOUNDRY, HEMATITE, BASIC, SPECIALS, &c.

NON-FERROUS METALS
COPPER, TIN, LEAD, SPELTER, ANTIMONY, CHROME ORE.

WILLIAM JACKS & COMPANY,
19, ST. VINCENT PLACE, GLASGOW.
ZETLAND ROAD, MIDDLESBROUGH.

SMALL ADVERTISEMENTS.

Notice.

Small Advertisements in this section of the Journal are accepted at the prepaid rate of 6d. per line, first line in capitals counting two, average 6 words per line. Minimum charge for one insertion 3/-

(A remittance should accompany instructions.)

SITUATIONS WANTED.

EMPLOYMENT REGISTER.

Conducted by the Institute of British Foundrymen by courtesy of the proprietors of THE FOUNDRY TRADE JOURNAL.

Any Member, Associate Member or Associate of the Institute of British Foundrymen who desires his qualifications to be inserted in the column must forward to the General Secretary of the Institute the following information:—(a) Name and address; (b) name of present employer (or last employer if unemployed); (c) brief particulars of qualifications, experience, and type of position required. The name will not be disclosed until the candidate is in communication with a prospective employer. Announcements will be inserted in two successive issues, unless announcers' requirements have been met with in the meantime.

Any employer wishing to communicate with a candidate should write to the General Secretary, quoting identification number.

The Institute of British Foundrymen and the Proprietors of THE FOUNDRY TRADE JOURNAL wish it to be clearly understood that they accept no legal responsibility in connection with this service, for which no charge is made to members of the I.B.F.

Correspondence should be addressed to the General Secretary, Institute of British Foundrymen, St. John Street Chambers, Deansgate, Manchester.

EXPERIENCED Moulder requires position as Foreman or Assistant. Experience in general engineering and jobbing castings on green and dry sand up to 50 cwts. I.C.S. graduate. Capable of estimating and fixing piece rates, cupola control, and mixing by analysis. (109)

PUBLIC School and University man with Foundry and Engineering training requires position. Has acted as Commercial Assistant to Managing Director, with supervision of Foundry and Machine Shop Costing, Estimating, Buying and Sales Management. (110)

YOUNG Foundryman with College training, Drawing Office, and some years' practical Foundry experience, requires Supervisory Position. Grey-iron castings up to 10 tons, also machine moulding. (111)

POSITION required as Foreman Moulder. Experience in dry sand and heavy green sand, also machine and plate moulding. (112)

FOUNDRY Manager requires post. Ten years in sole charge of 70 to 100 moulders. General engineering castings, green, dry, and loam, up to 20 tons; also machine moulding. Experience in piece-work and in metal mixing. (113)

FOUNDRY Foreman requires position. Iron and Non-ferrous experience, mass production and repetition methods. Used to piece-work and bonus systems. Has also had experience in general jobbing work. (114)

PROPERTY.

FOR Sale, Modern London Iron Foundry with railway siding facilities, on acre of land. Electric power and small machine shop; suitable for castings up to 3 tons in weight, capacity 20 tons per week. Overhead crane and all equipment. Easy terms of payment can be arranged.—Box 806, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

PROPERTY—*Continued.*

MAGNIFICENT

11 ACRES WORKS SITE.

SHEFFIELD.

145,000 Sq. Ft. of Shops.

SIDING CONNECTIONS

with L.M. & S. and L. & N.E. Rlys.

WELL-BUILT & COMMODIOUS OFFICES

Will Sell whole or in lots to suit customers or Let on favourable terms. Unique opportunity for Manufacturers.

Apply—

THOS. W. WARD, LTD.,
ALBION WORKS, SHEFFIELD.

WANTED to Purchase, Freehold Ground suitable for Iron Foundry, or would consider purchasing small foundry within 10 miles of London, south preferred; state full particulars and price. All correspondence will be strictly confidential.—Reply, Box 804, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

MACHINERY.

WANTED, Small Steel Converter, about 1 ton capacity, complete with Blower. Also Wanted, Air Compressor, suitable for working foundry moulding machines.—ALEX. HAMMOND, Foundry Machinery Merchant, 14, Australia Road, Slough.

SAND MIXERS.—New and Secondhand. Ask us to quote.—W. BREALEY & COMPANY, LIMITED, Station Works, Ecclesfield, Sheffield.

UNIVERSAL Mixers for Sand Colours, Chemicals, Blacklead, etc., different sizes. Also Super Abrasive Grinders and Steel Attrition Grinder and Dresser. Grind to any degree of fineness.—BOOTH & SON, Grinding, Crushing and Mixing Engineers, Congleton, Cheshire.

THOS. W. WARD, LTD.

Several No. 4 HERBERT Capstans, S.P.D., for chuck work.

No. 62 FELLOWS Gear Shaping Machine.

No. 60 and No. 70 HEALD Internal Grinding Machines.

Several Vertical Milling Machines.

2-ft. 0-in. gauge 4-wheel 6-in. x 9-in. LOCOMOTIVE (Kerr Stuart); steel firebox, steel tubes; 140 lbs. w.p.

ELECTRIC WARPING WINCH (Clarke Chapman), having two drums 20 in. dia. x 15 in. wide; drum coupled to motor, 100 volts, 200 amps.

Two LANCASHIRE BOILERS, 30 ft. 0 in. long x 8 ft. 3 in. dia., re-insurable at 150 lbs. per sq. in. working pressure.

New PRESSED STEEL SECTIONAL TANKS, plates 4 ft. 0 in. and 1 metre square; all capacities, easy to erect.

(ASK FOR "ALBION" MACHINERY CATALOGUE.)

ALBION WORKS, SHEFFIELD.

MISCELLANEOUS.

WANTED, Small Gas-Fired Crucible for Aluminium. — Particulars to SURREY ENGINEERING WORKS, 226, Whitehorse Road, Croydon.

GANISTER, best quality for cupolas, also for Steel Works.—ASTBURY SILICA COMPANY, "The Brooms," Park Lane, Congleton.

LADLES.

I HAVE EVERY SIZE LADLE in stock from 10 lbs. to 10 tons. Send me your inquiries. Any Ladle sent on approval. Buy from me and save money.—ALEX. HAMMOND, 14, Australia Road, Slough.

LINSEED OIL.—Re-tanked Linseed Oil, about 5 to 10 tons, for sale, £22 per ton ex-Hull; 3 tons also ex-Glasgow.—Write, Box 792, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

MISCELLANEOUS—*Continued.*

CORE STOVES.

One 9 ft. x 6 ft. x 3 ft.	£30
Two 6 ft. x 6 ft. x 3 ft.	£20
One 4 ft. x 4 ft. x 3 ft.	£10

Above are as new. All are silicate-packed. Suitable for gas- or coke-firing.

Lying at Britannia Foundry, Coventry.

A. HAMMOND,
14, Australia Road, Slough.

FOUNDRY SUPPLIES.—Quick and correct service by WILLIAM OLSEN, LIMITED, Hull, who are manufacturers and stockholders of all kinds of Materials and Requisites. Latest reduced Price Lists on application.

Our STRAW ROPES again reduced. See page 7.

ADDRESSOGRAPH Machine (Pedal), in good working order, with cabinet attached, including some drawers, for disposal.—Address replies to Box 1768, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

PATENT.

THE Proprietors of the Patent No. 226751 for Improvements in or relating to Processes for Incorporating Manganese with Iron are desirous of entering into arrangements by way of licence and otherwise on reasonable terms for the purpose of exploiting same and ensuring its full development and practical working in this country.—All communications should be addressed, in first instance, to HASELTINE, LAKE & COMPANY, 28, Southampton Buildings, Chancery Lane, London, W.C.2.

'Phone: 287 SLOUGH

SAND PLANT

Small Jackman SM4 Aerator...	£12
Halls Invincible mixer	£18
Herbert mixer, as new	£32
All above BALL BEARING.	
4 ft. "Universal" sandmill ...	£20
6 ft. "Jackman" sandmill ...	£38
"Pneulec" electric riddle ...	£12
"Macdonald" air riddle ...	£10

ALEX. HAMMOND, *Foundry Machinery Merchant,*
14, AUSTRALIA ROAD, SLOUGH

Bradley's

MIXTURE SERVICE

The Bradley Mixture Service is designed to enable the full benefit of Refined Irons, their unique properties, uniformity of quality and composition, to be available to the general foundry public.

The service is based upon a standard series of Refined Irons of guaranteed composition of which a stock is held continuously available at twenty-four hours' notice.

Full particulars of the Bradley Mixture Service are contained in an interesting booklet, a copy of which will be sent free on request.

BRADLEY & FOSTER LIMITED
IRONMASTERS
DARLASTON, STAFFS

Telegrams: "Bradley, Darlaston." Telephone: Darlaston 16 (P.B. Ex.)